



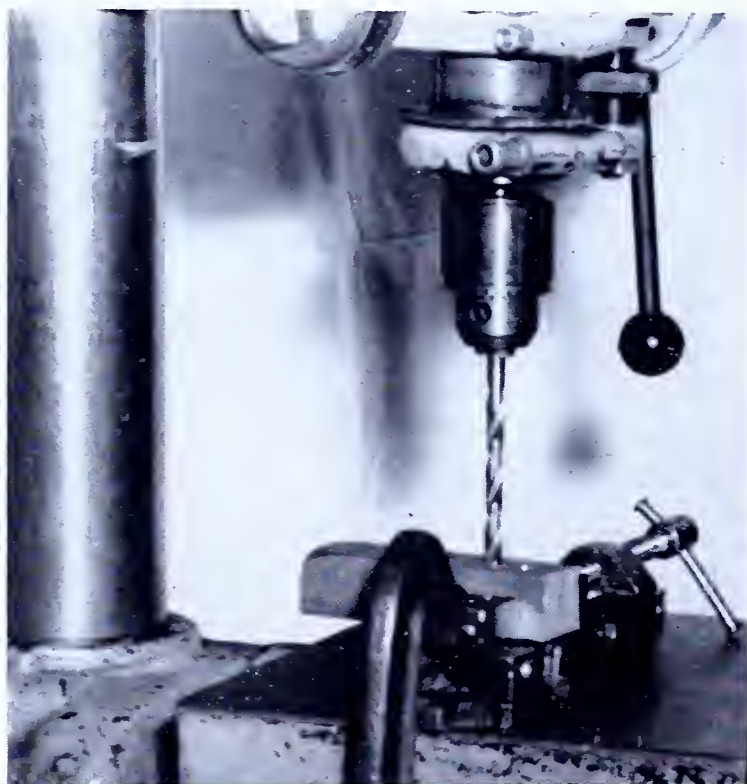


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# *Metal Machining*

AS AN AREA OF

**INDUSTRIAL ARTS INSTRUCTION IN  
PENNSYLVANIA PUBLIC SCHOOLS**



BULLETIN 331G • 1953

DRILLING

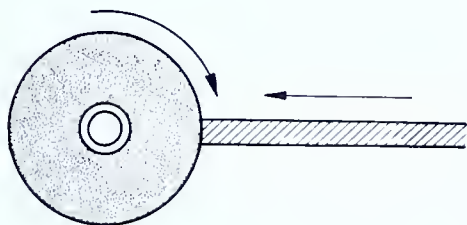
COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF PUBLIC INSTRUCTION • Harrisburg

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# Foreword

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IN THE BROAD AREA of Industrial Arts Education attention is being directed to the Metal Machining area of instruction which provides pupils with exploratory experiences in the use of hand and machine tools and metal machining materials. This area of instruction also develops an appreciation of the value, use, care, adjustment, and maintenance of the various hand and machine tools.

This bulletin is one of a series on specific areas of instruction in Industrial Arts Education. It provides detailed information pertaining to Metal Machining as an area of work in a comprehensive general shop. It supplements *Industrial Arts in Pennsylvania*, Bulletin 331, published in September, 1951, by the Department of Public Instruction.

*Metal Machining as an Area of Industrial Arts Instruction* was prepared by C. F. Fitz, Area Coordinator, Trade and Industrial Education, The Pennsylvania State College, under the supervision of Robert T. Stoner, Chief, Trade and Industrial Education. Preliminary work on manuscript and layout planning were done by R. Randolph Karch, Adviser, Trade and Industrial Education. Photographs and shop layout are the work of Lyle Weissenfluh, Adviser, Trade and Industrial Education. The photographs were taken in the York and Mechanicsburg School Districts.

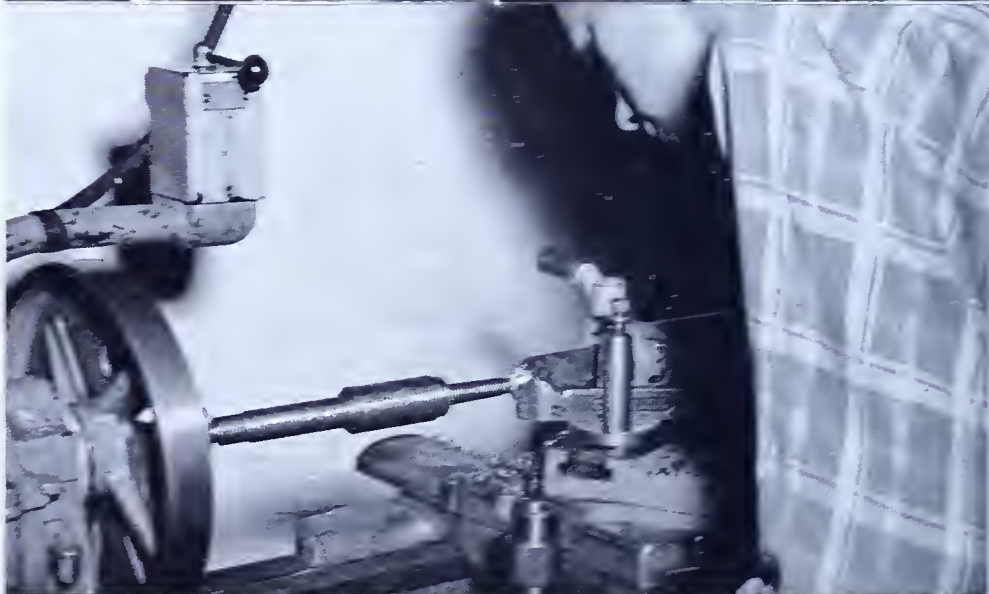
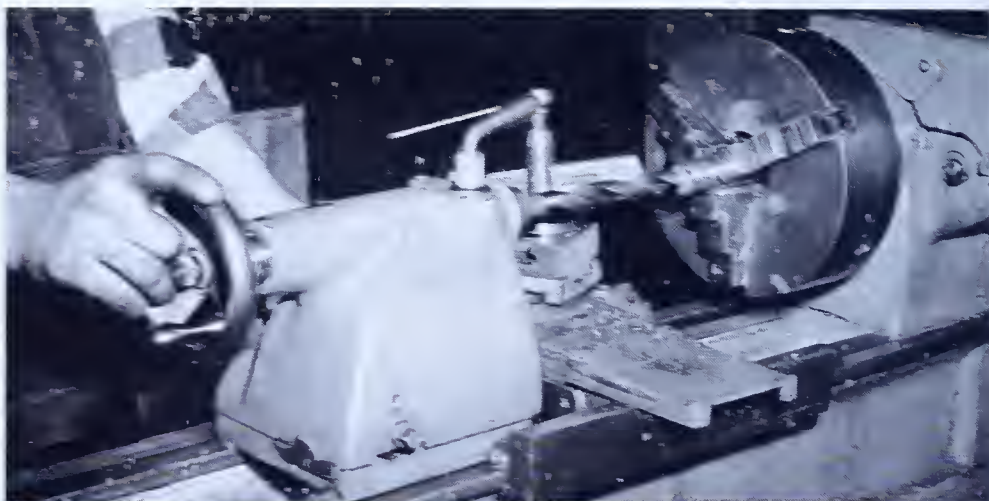
This bulletin has been edited by Rachel S. Turner, Editor for the Department of Public Instruction.

*Francis B. Hoar*

*Superintendent of Public Instruction*

JUNE 1953





LATHE OPERATIONS

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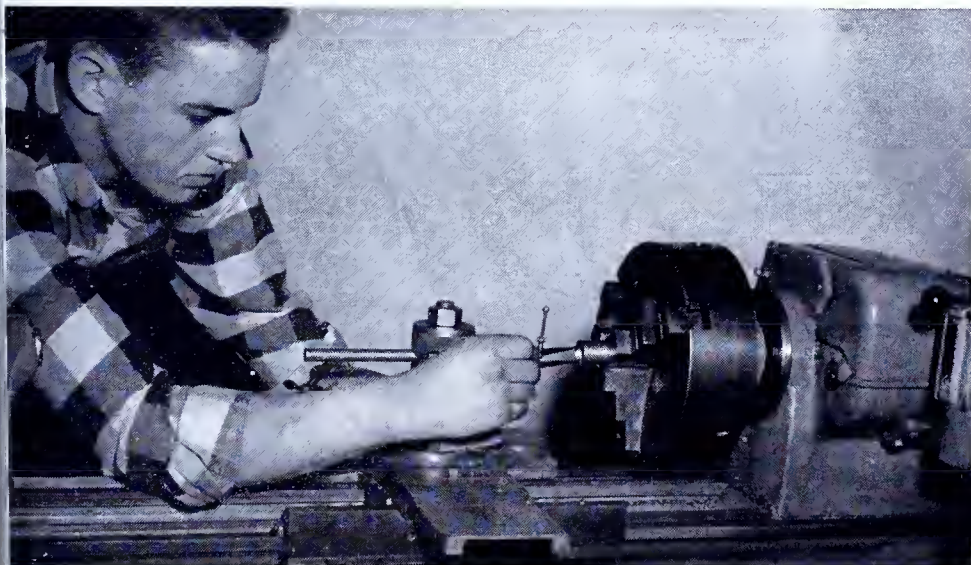
# Introduction

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BECAUSE of the differences in educational concepts, in backgrounds of the administrator and teacher, in variations in the time pupils spend in the activity, in amount of funds available for equipment and supplies, as well as in other factors, no attempt is made in this bulletin to set up a common course of study applicable to all situations, or to tell the teacher what to teach, how to teach, or what equipment he should have in his shop.

This bulletin does list, in the "The Things to Do and Things to Know" sections on pages 9 through 14, course content which may be selected by the teacher. These learning units also help to determine particular aims and objectives, amount of time available to pupils in the Metal Machining area, and the necessary equipment.

Suggestions to guide the administrator and the teacher are made on the organization of instruction, instructional material, tools and devices, possible projects, sample job assignments, and the use of records and forms, including samples of the information sheet and the operation sheet. Included for further guidance are a selected annotated bibliography of readily available instructional materials and visual aids, a suggested inventory of equipment and supplies,



**BORING**

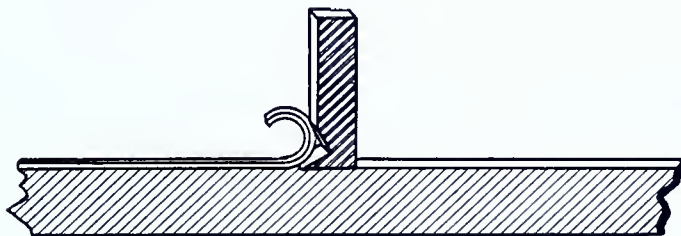
their approximate cost, feasible shop layout, and other information related to establishing or enriching the Metal Machining unit of a comprehensive general shop, or a unit (one activity) shop.

The suggestions of John F. Friese, Professor of Industrial Arts Education and Michael W. Knerr, Senior Area Coordinator, Trade and Industrial Education, The Pennsylvania State College, have been very helpful in the writing of this bulletin.

Matter pertaining to Industrial Arts in general is not discussed in this bulletin. For further information the reader is referred to Bulletin 331, *Industrial Arts in Pennsylvania*, published by the Department of Public Instruction, September, 1951.

# 1 Metal Machining\_\_\_\_\_

## AS A SCHOOL SUBJECT



THE REAL WEALTH of a nation is what it produces to meet human needs. The more the nation produces, the more products are available for distribution among its citizens, and the more their standard of living is raised.

Machine tools add to the output by increasing the worker's production. As Henry Ward Beecher said: "A tool is but the extension of a man's hand, and a machine is but a complex tool, and he that invents a machine augments the power of a man and the well-being of mankind."

Today the strength of a nation lies in its productive capacity. The same machines that help to speed the flow of the products of peace are indispensable to the manufacture of the weapons of defense.

Machine tools are the power-driven machines which cut or shape metal into desired forms. Many needs of man can be accurately and plentifully satisfied by using machine tools or the machinery and equipment made on machine tools.

### Scope of the Metal Machining Industry

The shape of metal is changed by two methods. The basic method is to melt the metal and pour it into molds or forms. Closely related to this "casting" method is the process of using heat to forge, weld, braze, or roll the metal. These methods are discussed in Bulletin 331-F, *Metal Forming*.

The second method of shaping metal is by cutting it. The machinist uses power tools to gain mechanical advantage, speed, and accuracy. This machining is usually applied to metal after it has been formed in the basic process explained above. This bulletin is limited to the second method of shaping metal—*Metal Machining*.

The various operations performed in a metal-working shop require many different types of machines, each especially designed to do a certain kind of work. Over 200 major types of machines exist in a number of sizes. Special work-holding and tool-holding devices, called "attachments", are applied to each size and type.

This tremendous array of machine tools may be readily classified under the five basic arts of shaping metal covered in this bulletin. These basic arts or operations are drilling or boring, planing or shaping, milling, turning, and grinding.

### **Aims and Objectives**

If instruction is to be purposeful to the pupil, aims and objectives must be established and developed. These are developed in terms of the goals desired and provide a basis for the selection of subject matter. The determination of aims and objectives is the starting point in the development of this particular area of instruction; it also serves as a means for the evaluation of progress in the subject. The Metal Machining area assists in the attainment of the broad general objectives of Industrial Arts education and provides experiences which assist in the development of the following specific objectives:

1. To develop a measure of skill in the use of common hand and machine tools
2. To develop an understanding of some of the problems involved in common types of construction, and in repair and maintenance of hand and machine tools
3. To understand that industrial America is conditioned by the many scientific developments in the machine tool industry
4. To develop an understanding and appreciation of the occupational opportunities created by the machine tool
5. To develop an interest and appreciation of the methods and problems of industrial production
6. To give the pupil consumer knowledge of machined products

### **Organization and Grade Levels**

The program outlined for Metal Machining suggests instruction designed for the junior or senior high school pupil. It is possible to offer some elementary phases in the upper junior high school grades, and more advanced work in the senior high school. Much flexibility

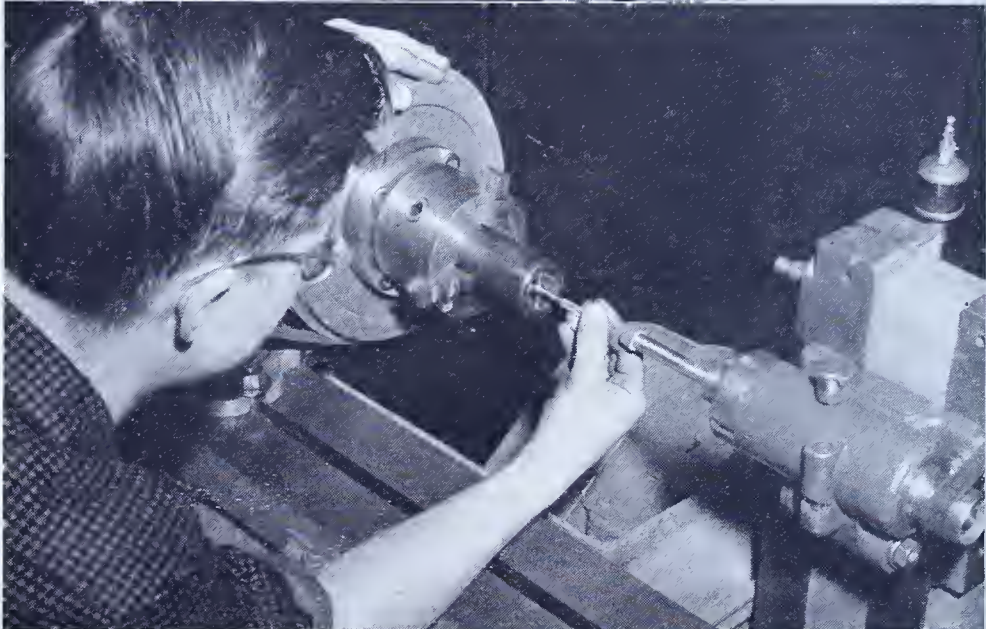
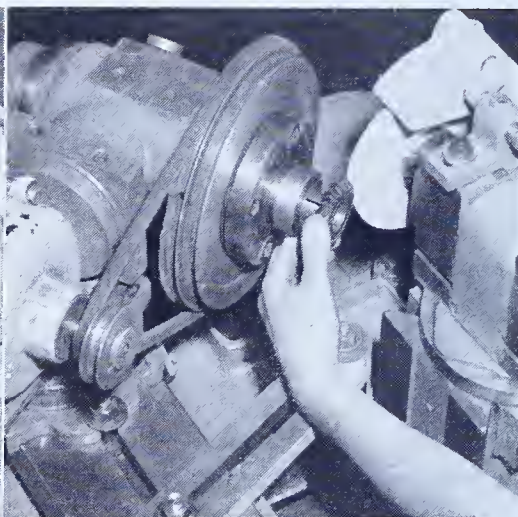
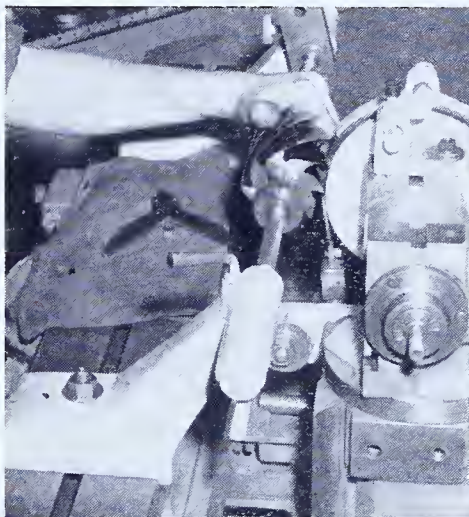


in this respect is possible because many operations are independent of one another and need not be followed in a fixed sequence. It is also possible to integrate and coordinate the work in Metal Machining with other areas of the comprehensive general Industrial Arts shop.

### **Allied Occupations**

Acquiring a comprehensive view of occupational fields is an increasingly difficult task because the problems of industry change rapidly. Young people, faced with the problem of choosing a vocation, naturally consider fields of work with which they have had some contact.

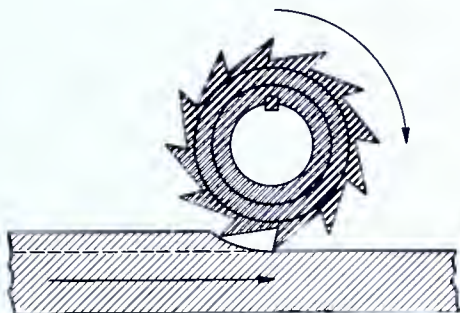
During the years when pupils are considering various occupations, it is an important function of Industrial Arts education to provide exploratory experiences and vocational information concerning occupational opportunities and employment requirements. The metal machining activity is well adapted to carry out this vocational guidance objective, since it provides experiences and information in one of the most important occupational fields.



**GRINDER OPERATIONS**

## 2 *Metal Machining*\_\_\_\_\_

### IN THE COMPREHENSIVE GENERAL INDUSTRIAL ARTS SHOP



THIS BULLETIN TREATS METAL MACHINING as an integral part of at least four activities in a comprehensive general Industrial Arts shop. The suggested list of tools, machinery, and supplies, pages 53 to 64, should be increased proportionately for a unit (one activity) metal shop.

#### **Metal Machining in a Unit Shop**

In school districts where the enrollment and local conditions justify an Industrial Arts program organized on the unit shop (one activity) basis, the suggested list of tools, machinery, equipment, and supplies should be increased proportionately to satisfy the increase in number of pupils. The size, type, and kind of tools, machinery, and equipment should be determined from the plan of instruction designed to meet the situation.

#### **Tools, Machinery, and Other Equipment**

Intelligent planning of the physical facilities, tools, machinery, and other equipment of the Industrial Arts shop plays a major role in determining the success of a good Industrial Arts program. In many instances members of the local board of education or school administrators need help to purchase equipment for an effective program. If it is possible, a qualified and certificated Industrial Arts teacher should be employed well in advance so that he may be consulted on the purchase of tools, machinery, and equipment, and on planning the shop layout. The selection of type and size of machinery for the



Metal Machining area is determined largely on whether it will be used for junior, junior-senior, or senior high school instruction. The purchase of too small or too light machinery is false economy, as the maintenance cost over a period of years usually becomes excessive and may equal or exceed the original purchase price of heavier and more costly machinery. Shop planning and layout are covered quite extensively on pages 95 through 112 in Bulletin 331, *Industrial Arts in Pennsylvania*, published in 1951 by the Pennsylvania State Department of Public Instruction. Technical advice and assistance can be had by contacting the area coordinator of Trade and Industrial Education responsible for the supervision of Industrial Arts in the local area.

## **Materials**

A wide variety of materials should be used to meet the broad objectives of Industrial Arts and to provide the pupil with the media for desirable experiences which will make him more adaptable in today's complex society.

Teachers of Metal Machining are inclined to limit project materials to cold-rolled steel. Various kinds of metals should be used so that pupils may become acquainted with the many metals used today in our metalworking industries. Instruction should also be given on screws, solder, rivets, nuts, and finishes—materials which are usually part of the completed project.

In the selection of projects some consideration should be given to the use of a combination of materials and operations by combining the activities and materials of several shop areas in the construction of the project. For example, where woodworking, planning, foundry, and metal machining are included as areas of a comprehensive general Industrial Arts shop, an ash tray may combine the four activities. The project could be designed in the Planning area, the wooden pattern could be made in the Woodworking area, the casting done in the foundry of the Metal Forming area, and the machining of the casting in the Metal Machining area.

## **Use of Power Machines**

This unit on Metal Machining involves, primarily, the use of power-driven machines. The grade level permitted to use such machines varies with the teacher's philosophy and with the pupils' abilities, maturity, age, emotional stability, and physical condition. It is important, however, that the Industrial Arts teacher teach safety as it applies to the power-driven machines in his shop.

**Suggested Safety Program**

All pupils enrolled in the Metal Machining area should receive written permission from their parents or guardians to operate the power-driven machines in this area. Parents' or guardians' signatures on cards provided for this purpose are necessary. These cards are signed in duplicate. One card remains in the teacher's file under Pupil Personnel; the other is filed in the principal's office.

The obverse and reverse sides of this 3" x 5" Machine Operation Permit are shown below:

**MACHINE OPERATION PERMIT**

**To the Industrial Arts Teacher**

My signature below signifies permission for my son, \_\_\_\_\_, to use the power-driven machines indicated on the reverse side of this card, with the provision that thorough instruction in safe operation will be given by the teacher.

\_\_\_\_\_  
*Signature of Parent or Guardian*

\_\_\_\_\_  
*Date*

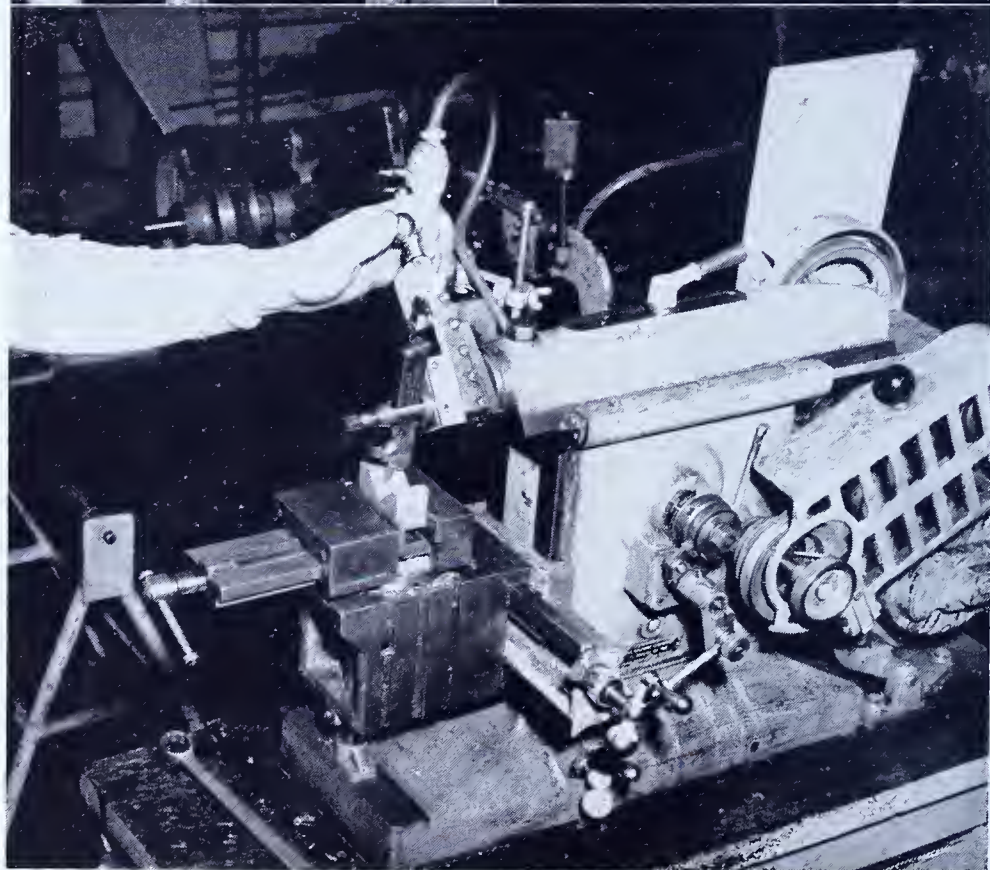
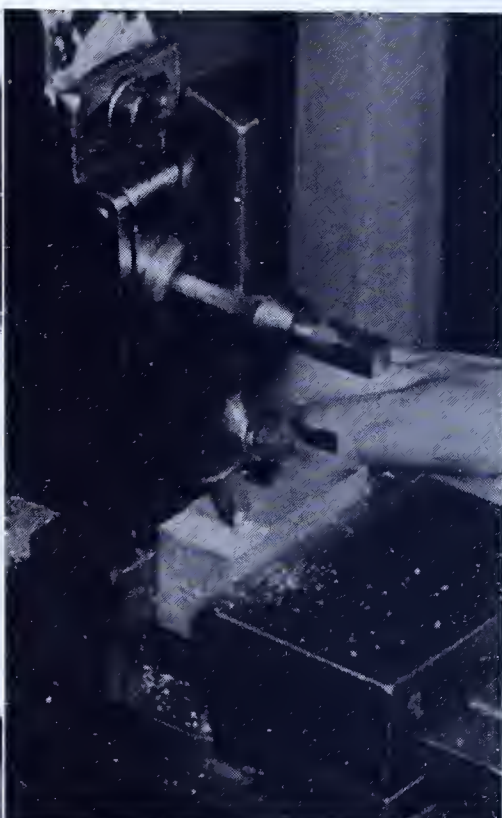
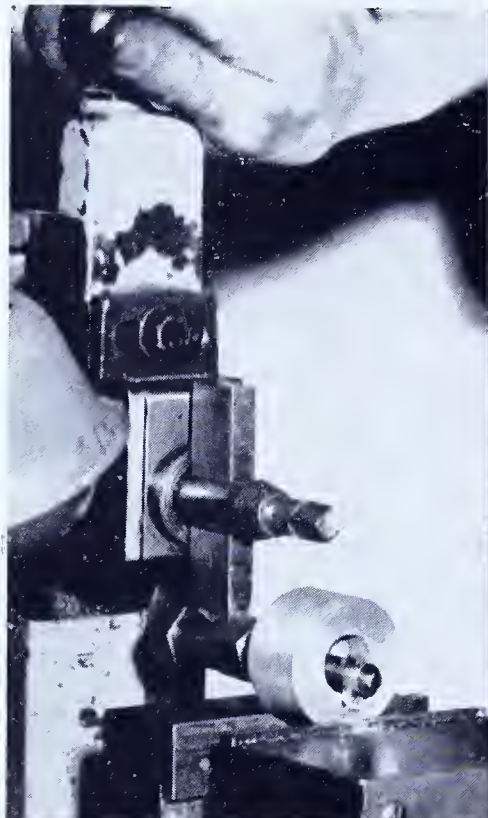
**REVERSE OF MACHINE OPERATION PERMIT**

**Machine Operation Permit**

- |                      |                        |
|----------------------|------------------------|
| _____Engine Lathe    | _____Pedestal Grinder  |
| _____Drill Press     | _____Universal Grinder |
| _____Shaper          | _____Power Hack Saw    |
| _____Milling Machine |                        |

List below additional machines available:

\_\_\_\_\_  
\_\_\_\_\_

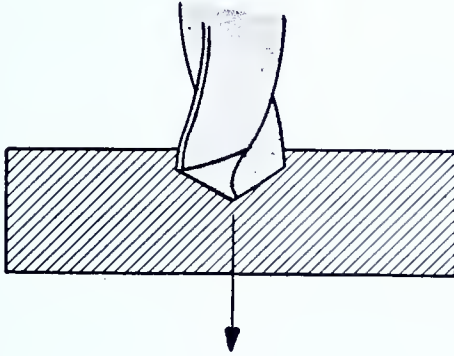


SHAPER OPERATIONS



# 3 Learning Units\_\_\_\_\_

## THINGS TO DO AND THINGS TO KNOW



IN ANY INDUSTRIAL ARTS ACTIVITY the basis for the selection of subject matter to be included as learning units is determined through an analysis of the operations and processes of industry. This analysis provides a list of the manipulative or practical learning units as well as informational content. Final selection of subject matter is based on those experiences which are representative and fundamental to the activity, and which will contribute toward the attainment of the objectives of the program. The final result is a list of learning units representing the things a pupil should be able to do and the things he should know.

“Things to Do and Things to Know” in the Metal Machining area should include, therefore, the basic processes of shaping metal, and should be classified under the following divisions:

- |                   |                      |
|-------------------|----------------------|
| 1. ENGINE LATHE   | 4. MILLING MACHINE   |
| 2. DRILL PRESS    | 5. PEDESTAL GRINDER  |
| 3. SHAPER         | 6. UNIVERSAL GRINDER |
| 7. POWER HACK SAW |                      |

### THINGS TO DO

These learning units will assist the Industrial Arts teacher in developing his plan of instruction:

#### ENGINE LATHE

1. Start, stop, and reverse the lathe
2. Clean, oil, and maintain the lathe

3. Grind and/or sharpen tool bits for roughing:
  - a. aluminum
  - b. brass
  - c. cast iron
  - d. cold-rolled steel
  - e. tool steel
  - f. wrought iron
4. Grind and/or sharpen tool bits for finishing:
  - a. aluminum
  - b. brass
  - c. cast iron
  - d. cold-rolled steel
  - e. tool steel
  - f. wrought iron
5. Grind and/or sharpen:
  - a. boring tools
  - b. facing tools
  - c. parting tools
  - d. threading tools
6. Set the above tools for the job at hand
7. Regulate cutting speeds and feeds for the job at hand
8. Prepare work for mounting between centers
9. Mount work between centers
10. Remove and replace centers
11. Test live center for accuracy
12. True centers
13. Test for alignment of centers
14. Put on and remove faceplate
15. Mount work on faceplate
16. Put on and remove a chuck
17. Center cylindrical work in a chuck
18. Center irregularly shaped work in a chuck
19. Center hollow-ring work in a chuck
20. Lay out work in the lathe
21. Part work with a parting tool
22. Turn rough cylindrical work
23. Turn finished cylindrical work
24. Face work with:
  - a. facing tool
  - b. round-nosed tool
25. Cut the following:
  - a. acme threads
  - b. external national coarse threads
  - c. fillets
  - d. internal national coarse threads
  - e. square shoulders
  - f. tapers with:
    - (1) broad-nosed tool
    - (2) compound rest
    - (3) taper attachment
    - (4) tailstock setover
  - g. taper threads
26. Turn irregular work
27. Set up a collet chuck
28. Set up work in jigs and fixtures
29. Mount work on arbor for turning
30. Regulate speed and feed of lathe
31. Bore with a boring tool
32. Turn work with aid of follow rest
33. Turn work with aid of steady rest
34. Center drill
35. Drill

36. Ream
37. File
38. Polish
39. Knurl
40. Caliper work in the lathe with:
  - a. inside spring calipers
  - b. outside spring calipers
  - c. inside micrometer calipers
  - d. outside micrometer calipers

#### DRILL PRESS

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> <li>1. Start and stop the drill press</li> <li>2. Clean, oil, and maintain the drill press</li> <li>3. Adjust speed of the drill press</li> <li>4. Set up work on the table</li> <li>5. Set up work in the vise</li> <li>6. Set up work in jigs and fixtures</li> <li>7. Lay out work for drilling</li> <li>8. Center drill</li> <li>9. Ream</li> <li>10. Tap</li> <li>11. Countersink</li> <li>12. Counterbore</li> <li>13. Spot-face</li> <li>14. Bore</li> <li>15. Polish</li> <li>16. Spot</li> <li>17. Drill oversize holes</li> </ol> | <ol style="list-style-type: none"> <li>18. Drill holes at an angle to a surface</li> <li>19. Drill holes to required depth</li> <li>20. Drill holes in cylindrical work</li> <li>21. Bottom drill</li> <li>22. Regulate cutting speeds and feeds for the job at hand</li> <li>23. Grind and/or sharpen drills for drilling:               <ol style="list-style-type: none"> <li>a. aluminum</li> <li>b. brass</li> <li>c. cast iron</li> <li>d. cold-rolled steel</li> <li>e. tool steel</li> <li>f. wrought iron</li> </ol> </li> <li>24. Grind drills for countersinking</li> <li>25. Grind drills for bottom drilling</li> </ol> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

#### MILLING MACHINE

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> <li>1. Start, stop, and reverse the milling machine</li> <li>2. Clean, oil, and maintain the milling machine</li> <li>3. Adjust speed and feed of the milling machine</li> <li>4. Set up cutters on arbor</li> <li>5. Set up end mills</li> <li>6. Set up for face milling</li> <li>7. Plain mill</li> <li>8. Side mill</li> <li>9. Line table, vise, and work with cutter</li> <li>10. Set feed trips</li> <li>11. Set up work in vise</li> <li>12. Set up work on table</li> </ol> | <ol style="list-style-type: none"> <li>13. Set up work in jigs and fixtures</li> <li>14. Profile</li> <li>15. Gang mill</li> <li>16. Angular mill</li> <li>17. Straddle mill</li> <li>18. Taper mill</li> <li>19. Flute</li> <li>20. Slit</li> <li>21. Drill</li> <li>22. Bore</li> <li>23. Fly cut</li> <li>24. Ream</li> <li>25. Index work               <ol style="list-style-type: none"> <li>a. direct</li> <li>b. simple</li> </ol> </li> </ol> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### POWER HACK SAW

1. Start and stop the saw
2. Clean, oil, and maintain the saw
3. Adjust feed pressure
4. Change blades in the saw
5. Feed the saw into the work
6. Adjust stock gauge
7. Set up and clamp work in vise for straight cuts
8. Set up and clamp work in vise for angular cuts
9. Adjust stock stand
10. Adjust the limit switch
11. Saw thin stock on the machine
12. Saw hollow stock on the machine

### SHAPER

1. Start and stop the shaper
2. Clean, oil, and maintain the shaper
3. Adjust speed and feed of the shaper
4. Adjust the stroke
5. Grind and/or sharpen tools for roughing:
  - a. aluminum
  - b. brass
  - c. cast iron
  - d. cold-rolled steel
  - e. tool steel
  - f. wrought iron
6. Grind and/or sharpen tools for finishing:
  - a. aluminum
  - b. brass
  - c. cast iron
  - d. cold-rolled steel
  - e. tool steel
  - f. wrought iron
7. Set up work in vise
8. Set up work on table
9. Set up work on side of table
10. Set up work in jigs and fixtures
11. Make a roughing horizontal cut
12. Make a finishing horizontal cut
13. Machine surfaces at right angles
14. Machine angular surfaces
15. Machine curved surfaces
16. Machine tapered surfaces
17. Shape internally
18. Shape V's
19. Shape dovetails
20. Shape T slots
21. Cut a keyway in shaft
22. Cut a keyway in a hub
23. Undercut
24. Graduate

### PEDESTAL GRINDER

1. Start and stop the grinder
2. Clean, oil, and maintain the grinder
3. Inspect the grinding wheel for soundness
4. Dress the grinding wheel
5. Adjust the tool rests
6. Sharpen a center punch
7. Sharpen a flat chisel
8. Sharpen a scribe
9. Sharpen a twist drill
10. Do offhand grinding

### UNIVERSAL GRINDER

1. Start and stop the grinder
2. Clean, oil, and maintain the grinder
3. Adjust the speed of the grinder
4. Inspect the grinding wheel for soundness
5. Dress the grinding wheel
6. Mount grinding wheel to meet the needs of the job

- |                                |                                          |
|--------------------------------|------------------------------------------|
| 7. Grind a flat surface        | 19. Grind straight tooth milling cutters |
| 8. Grind a vertical surface    | 20. Grind helical tooth milling cutters  |
| 9. Grind angularly             | 21. Grind side milling cutters           |
| 10. Grind slots                | 22. Grind end mills                      |
| 11. Grind to shoulders         | 23. Grind straight reamers               |
| 12. Form grind                 | 24. Grind taper reamers                  |
| 13. Straight cylindrical grind | 25. Grind form tools                     |
| 14. Taper cylindrical grind    | 26. Grind jointer blades                 |
| 15. Angular cylindrical grind  | 27. Grind router bits                    |
| 16. Straight internal grind    | 28. Grind tool bits                      |
| 17. Taper internal grind       |                                          |
| 18. Face-grind                 |                                          |

## **THINGS TO KNOW**

To develop a plan of instruction for the Metal Machining area which meets the non-manipulative values and outcomes of an Industrial Arts program, the teacher must allow time for instruction relative to the technical aspects, consumer knowledge, and guidance values inherent in any good program. The following information units will assist the teacher in developing his plan of instruction.

### **MACHINE TOOLS**

The following information units apply to all power-driven machines:

1. The type and general description of the machine, its size, capacity, and principal uses
2. The names and functions of the principal parts of the machine
3. The different working speeds and feeds of the machine and how they are obtained
4. How the lines of power are transmitted through the machine and how the different types of motion are produced

### **HAND TOOLS**

1. Kinds of hand tools and their uses
2. Protection of edged tools
3. Size of drills
4. Size of taps
5. Size of center drills
6. Kinds and sizes of hack-saw blades

### **METALS**

1. Identify: aluminum, brass, cast iron, cold-rolled steel, tool steel, and wrought iron
2. Principal characteristics, working properties, chief uses, and important sources of supply of the above metals
3. Methods of producing the above metals
4. Standard stock sizes
5. Costs and methods of ordering metal

## **FASTENERS**

1. Kinds of cotter pins
2. Uses of the different kinds of cotter pins
3. Sizes of cotter pins
4. How cotter pins are sold
5. Kinds of machine screws
6. Uses of the different kinds of machine screws
7. Sizes of machine screws
8. How machine screws are sold
9. Kinds of machine nuts
10. Uses of the different kinds of machine nuts
11. Sizes of machine nuts
12. How machine nuts are bought

## **ABRASIVE CLOTH**

1. Kinds
2. Grades
3. Principal uses
4. Reasons for finishes
5. Durability of various finishes

## **OCCUPATIONS**

1. Machinist
2. Toolmaker
3. Diemaker
4. Jig and fixture maker
5. Gauge maker
6. Assembler
7. Layout man
8. Lathe operator
9. Milling machine operator
10. Drill press operator
11. Grinder operator
12. Shaper operator
13. Power-saw operator

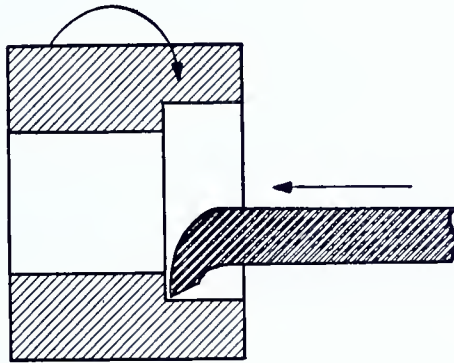
## **OCCUPATIONAL INFORMATION**

1. Wage and hour regulations
2. Union organizations
3. Apprenticeship programs
4. Opportunity for promotion in the metal industry
5. The effects of the machine tool industry on social, economic, and political life
6. New metals and alloys



# 4 Organization of Instruction

## INSTRUCTIONAL MATERIAL AND DEVICES



METAL MACHINING INSTRUCTION is planned around shop projects. The making of a project leads the pupil through the various learning units. Projects for beginning pupils should comprise only a small number of learning units and should be selected by the pupil under the guidance of the teacher. Subsequent projects should include new learning units and provide practice in the old. A display case of finished products is helpful in motivating the pupil's interest and in aiding him in the selection of his project.

All projects should conform to definite established standards and should:

1. Contain some of the learning units desired
2. Be simple enough to be in the range of the pupil's ability but difficult enough to challenge his resourcefulness
3. Be of such a nature that they can be produced under school shop conditions
4. Employ good design and have some value to the home or community
5. Be of such a nature that they can be completed within a reasonable time
6. Have value in the pupil's estimation and stimulate further interest

## Shop Management Organization

As the activities presented in Industrial Arts shops are increased in number and scope, it is expedient for the teacher to assign some of the routine duties to pupils. The purpose and plan will not be the same for all schools but will depend on the type of activities offered, size of class, age of pupils, length of periods, and physical layout of the shop. The assignment of routine duties is emphasized at this point because it is an effective device for achieving the following Industrial Arts objectives:

1. To develop desirable pupil attitudes of leading and following
2. To aid the teacher with the many routine duties
3. To aid in motivating the pupils' interest and understanding of industrial operations and applications

The shop management plan may be organized by the class. Because a teacher-imposed plan is readily recognized by pupils and has a tendency to decrease pupil interest, better cooperation can be developed through a personnel plan developed by the pupils under teacher guidance and direction. Pupils may assist in the development of the plan as a class or through a committee of pupils from several classes. A plan developed in this manner motivates the pupils' interest in industrial personnel organizations and provides an incentive for the study of local plant personnel systems. This is valuable in developing a well-organized plan for the school. The added cooperation attained and the guidance value received by the pupils more than compensates for the extra time spent in the democratic development of this plan. Suggestions for the development of a student personnel organization plan are given on page 83 in Bulletin 331, *Industrial Arts in Pennsylvania*, September, 1951.

In order to make a pupil shop management plan operate successfully, its importance, need, and practicability must be explained carefully to the pupils. The success of the program depends entirely upon the pupils' acceptance. The teacher should plan his presentation carefully in order to justify in the minds of the pupils the value and need of such a program.

Use of Records, Forms, and Charts

The Industrial Arts teacher of a comprehensive general shop is confronted with many problems pertaining to the administration of the program, details of instruction, and the handling of supplies. The number of problems increase as the activities in the shop become more diversified. Development of adequate record-keeping forms and charts and the maintenance of accurate up-to-date data are important responsibilities of the Industrial Arts teacher. If properly developed, these activities will not be time-consuming and monotonous, but will aid the teacher in showing teacher-pupil progress, as well as aid in the evaluation, development, and improvement of the program. Care must be exercised so that the teacher does not become so involved with record keeping that he becomes a clerk. Instead, a plan should be devised whereby pupils and teacher share the work of recording progress and learning units.

Progress Chart

The use of a pupil progress chart is of particular importance in the operation of the Metal Machining activity. Since the projects made by the pupils are established through an analysis of basic machine tool

Course

Grade

Section

Days

Periods

PROGRESS CHART

Semester

Year

Pupils' Names	Information Units					JOBS				

Sample Progress Chart to Show Accomplishment of Pupils Throughout the School Year.

operations, they may consist of items which require metal machining but are made in other areas of the shop. It is essential that an accurate record of each pupil's accomplishment be maintained on a progress chart. A suggested progress chart is shown on page 17.

**Pupil Cumulative Project Record**

While projects are not considered as ends in themselves but rather as the means to an end, the nature and number of projects completed by the pupil are indicative of the extent to which the objectives of the program are being met. The use of this record is particularly important in the comprehensive general Industrial Arts shop where activities are highly diversified. A suggested cumulative project record is shown below.

NameGrade 7 8 9 10 11 12 PG

---

PUPIL CUMULATIVE PROJECT RECORD

Industrial Arts DepartmentSchoolCity

---

Shop	Project	Activity	Date Started	Date Finished	Total Periods	Teacher	Cost	Paid	Grade

**Instruction Sheets**

When shop work was first introduced into the public schools, teachers felt that it provided a means of escape from the “drudgery” of books. Because of this fact, very little use was made of written instructional materials in the teaching of Industrial Arts. In recent years, however, since emphasis in Industrial Arts philosophy is developing toward the comprehensive general shop, teachers are aware

that the multi-activity shop can be taught most effectively through the use of instruction sheets. Written instruction sheets are of great value in giving different backgrounds, interests, and abilities. Instruction sheets are particularly helpful in giving individual instruction where pupils progress independently at their own rate of speed.

The advantages of using individual instruction materials are as follows:

1. The teacher has more time to select instructional material and to arrange it in the best learning order.
2. More accurate instruction is possible.
3. The pupil is responsible for seeking out information.
4. Instruction material lends itself to accurate record keeping and checking.
5. Larger classes can be handled more effectively.
6. The teacher has more time for individual help.

#### *Suggestions for Writing Instruction Sheets*

1. The whole scheme should evolve out of the project.
2. The project should appeal to:
  - a. the pupils' interests
  - b. home interests
  - c. play or amusements
  - d. school activities
3. Construction of the project should be within the pupils' capabilities.
4. The project should be made by one or more operations:
  - a. lathe
  - b. drill press
  - c. bench
  - d. shaper
  - e. milling machine
  - f. grinder
5. The Information Sheet should convey to the pupil such information as:
  - a. knowledge of tools
  - b. knowledge of processes and operations
  - c. knowledge of and respect for materials and labor
6. The project should stimulate thought.
7. The operations should be listed in proper sequence.
8. The project should call the pupil's attention to some knowledge of trade science inherent in the job.
9. The project should acquaint the pupil with as much of the shop vocabulary as he can acquire.

#### *Sample Instruction Sheets*

The following pages illustrate several kinds of instruction sheets including:

- A SAMPLE PUPIL PROJECT PLANNING SHEET
- TWO TYPES OF SAMPLE PUPIL PROJECT ASSIGNMENT SHEET
- A SAMPLE PUPIL INFORMATION SHEET
- A SAMPLE PUPIL OPERATION SHEET

## SAMPLE PUPIL PROJECT PLANNING SHEET

\_\_\_\_\_ *High School*

\_\_\_\_\_ *School District*

*Name*\_\_\_\_\_ *Grade*\_\_\_\_\_ *Section*\_\_\_\_\_

*Project*\_\_\_\_\_ *Teacher Approval*\_\_\_\_\_ *Date*\_\_\_\_\_

SKETCH: Make a working sketch below of the project to be made.

PROCEDURE: List the principal steps in doing the project, showing what you will do first, second, third, etc.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_





# SAMPLE PUPIL PROJECT ASSIGNMENT SHEET—A

## TO LOCATE CENTERS

### OBJECTIVE:

To develop an understanding of the various methods of locating centers in stock

### REFERENCES:

Burghardt, Henry D., *Machine Tool Operation*, Part I., pp. 114-117  
Sheldon Machine Company, Inc., *The Care and Operation of a Lathe*, pp. 51-55

### PROCEDURE:

- I. Study the above references very carefully, paying close attention to the illustrations of methods of locating centers.
- II. Close all reference books and fill in the blanks to complete the following statements:
  1. There are \_\_\_\_\_ common methods of locating centers in stock.
  2. The simplest method of locating the center in round stock is the \_\_\_\_\_ method.
  3. The \_\_\_\_\_ method is generally used for locating the center in irregular round stock.
  4. The center in an irregularly shaped casting or forging is located by the \_\_\_\_\_ method.
  5. Rectangular pieces are centered by \_\_\_\_\_.
  6. A \_\_\_\_\_ is used to mark the intersection of the layout lines.
  7. The first thing to do in centering stock is to \_\_\_\_\_ the stock to see if it will finish to the required size.
  8. After the centers have been located with the center punch, their accuracy should be \_\_\_\_\_ before center drilling.
  9. If the centers are inaccurate, they are corrected by holding the \_\_\_\_\_ at an \_\_\_\_\_, \_\_\_\_\_ the direction the center is to be moved.
  10. The common methods of centering stock are: \_\_\_\_\_.

## SAMPLE PUPIL PROJECT ASSIGNMENT SHEET—B

### TO MAKE A NUTCRACKER

MATERIAL REQUIRED: Machine steel, band iron, 8d nail, drawing

OPERATIONS: Centering, facing, turning, knurling, slotting, filing, riveting

<i>Procedure</i>	<i>Machines and Tools Required</i>
1. Study drawing . . . . .	
2. Cut stock to length . . . . .	Hack saw, scale, vise
3. Center stock . . . . .	Center square, center punch, hammer, chalk
4. Center drill . . . . .	Drill press, center drill
5. Face to length . . . . .	Lathe, lathe dog, tool holder, r. h. side tool bit, scale
6. Straight turn . . . . .	Lathe, lathe dog, tool holder, turning tool bit, calipers, scale
7. Polish . . . . .	Lathe, mill file, emery cloth
8. Knurl . . . . .	Lathe, knurling tool
9. Round ends . . . . .	Lathe, tool holder, forming tool
10. Slot . . . . .	Hack saw, vise, scale
11. Drill for rivet . . . . .	Drill press, 1/8" twist drill
12. File teeth . . . . .	Vise, dividers, scale, saw, file
13. Saw out on line . . . . .	Hack saw, vise, scale
14. File line . . . . .	Mill file, vise, scale
15. Drill holes for rivets . . . . .	Drill press, 1/8" twist drill, scale, scriber, center punch, hammer
16. Assemble and rivet . . . . .	8d nail, hack saw, hammer

### SHOP TERMS

Slotting, knurling, riveting.

### SHOP KINKS A PROBLEM IN THIS PROCEDURE

When drilling rivet holes in handles, place a piece of flat stock in slot extending to the edge of the "V" block to make sure that holes will be at right angles to slot.

### SAFETY HINTS

Keep dead center well lubricated.

REFERENCE: Burghardt, Henry D., *Machine Tool Operation*. Chapters: V, VI, VII, XIV

### KNOWLEDGE OF STOCK

REFERENCE: Burghardt, Henry D., *Machine Tool Operation*. Part I, Chapters: V, VI, VII, IX, X

# SAMPLE PUPIL INFORMATION SHEET

## TYPES OF STEEL

### OBJECTIVE:

To develop an understanding of some of the common types of steel used in the Metal Machining area.

### REFERENCES:

Henry Ford Trade School, *Shop Theory*. pp. 1-3

Brown and Sharpe, *A Guide For Young Machinists*. pp. 237-245

### INFORMATION:

Steel is an alloy of iron and carbon. Among the other elements found in steel are silicon, phosphorus, sulphur, and manganese.

Steels may be roughly classified as straight carbon and alloy steels. A straight-carbon steel owes its properties chiefly to the various percentages of carbon with varying amounts of other alloying elements. Steel that contains about 0.20 per cent or less carbon may be called low-carbon steel, from 0.20 to about 0.60 per cent carbon may be called a medium-carbon steel and from 0.60 to 1.30 per cent carbon may be called a high-carbon steel.

An alloy steel is steel to which some element other than carbon has been added to improve or change its physical properties. Some of the alloying elements that are added to steel in addition to carbon are chromium, vanadium, nickel, molybdenum, and tungsten. Alloying elements are put into steel to secure greater hardness, and greater strength; to enable the steel to hold its shape and size during heat treatment; or to enable the steel to retain its hardness at high temperatures.

Machine steel is made from pig iron by reducing the carbon content and removing impurities in a Bessemer converter or by the open-hearth process. It is a low-carbon steel and can be easily machined. It is tough, ductile, malleable and has a high compressive strength and shock resistance. Being low in cost, it is used in machinery where resistance to shock is necessary, but where no cutting edge or hardened surface is required.

Cold-rolled steel has all the characteristics of machine steel. It is made by passing machine steel through highly finished rollers under great pressure. This process gives it a smooth finish and produces stock very close to the wanted size.

## TEST

[Test based on references, page 24]

1. Steel is an alloy of \_\_\_\_\_ and \_\_\_\_\_
2. Four other elements found in steel are:
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
  - d. \_\_\_\_\_
3. Low-carbon steel contains: (circle correct letters)
  - a. 0.20-0.60 per cent carbon.
  - b. 0.20 per cent or less carbon.
  - c. 0.60-1.30 per cent carbon.
4. Medium steel contains:
  - a. 0.20-0.60 per cent carbon.
  - b. 0.20 per cent or less carbon.
  - c. 0.60-1.30 per cent carbon.
5. High-carbon steel contains:
  - a. 0.20-0.60 per cent carbon.
  - b. 0.20 per cent or less carbon.
  - c. 0.60-1.30 per cent carbon.
6. Alloy steel contains elements other than carbon:
  - a. True \_\_\_\_\_
  - b. False \_\_\_\_\_
7. Four alloying elements of steel are:
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
  - d. \_\_\_\_\_
8. Alloys are added to steel for the following reasons:
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
  - d. \_\_\_\_\_



# SAMPLE PUPIL OPERATION SHEET

## HOW TO CENTER ROUND STOCK

### OBJECTIVE:

To learn how to center round stock for turning between centers on a lathe by the center-square method.

### OPERATION:

—To center round stock for turning between centers on a lathe.

### REFERENCE:

Burghardt, Henry D., *Machine Tool Operating*. Part I, Chapter V.

### ESSENTIAL TOOLS:

#### *Hand Tools Used:*

1. vise
2. mill file
3. chalk
4. center square
5. scribe

6. center punch

7. hammer

#### *Machine Tools Used:*

1. lathe
2. drill press

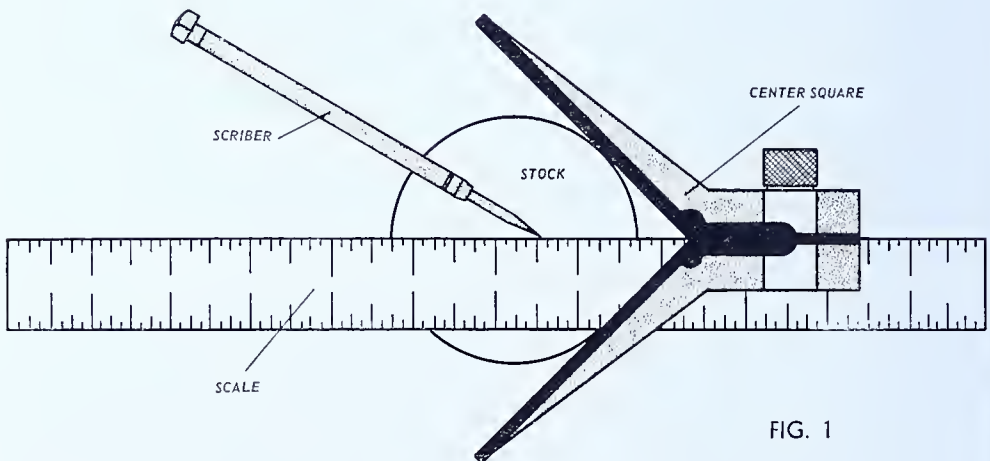


FIG. 1

### PROCEDURE:

1. Grip stock in vise.
2. Smooth ends with mill file.
3. Remove sharp edges from ends with mill file.
4. Rub white chalk on ends.

5. Hold both legs of the center square against the surface of the work and with a scribe draw a line along the edge of the scale (Fig. 1, on opposite page). Move the center square so that it will be at a right angle to the line drawn. Draw another line (Fig. 2 below). The intersection of these lines marks the center.
6. Steady center punch with finger and strike lightly with hammer.
7. Place work between lathe centers, spin the work, and test its accuracy by holding chalk near each end (Fig. 3 below). If the centers prove inaccurate, correct them by holding the center punch at an angle opposite the direction the center is to be moved. Repeat if necessary.
8. Enlarge center punch marks with heavier blows of the hammer before drilling.



FIG. 2

LINES SCRIBED ON END OF STOCK

9. On the drill press, place a combination center drill and counter-sink in the chuck, place stock in drill press vise secured to drill press table, line up work with center drill, start drill press, drill one end. Reverse the work and drill the other end.

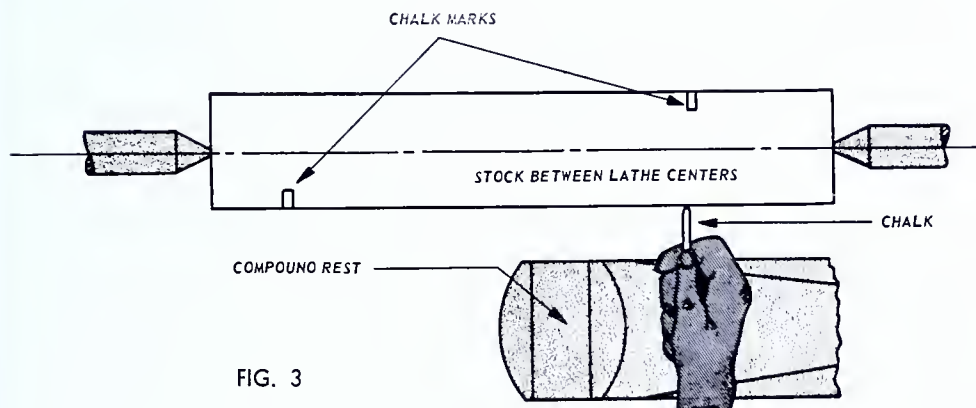


FIG. 3

## PARTIAL CHECK LIST FOR CARE OF SHOP

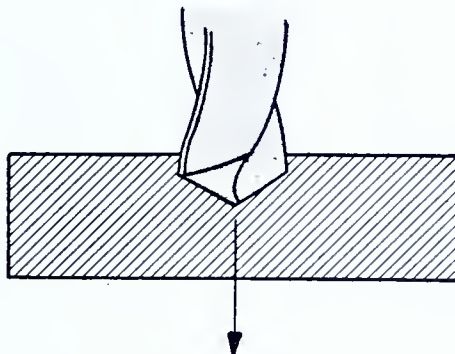
This partial check list is for periodic teacher evaluation of the condition of the shop. It may also be used by the pupil foreman in evaluating and checking on the work of the clean-up personnel.

TEACHER	Yes	No
1. A place for everything and everything in its place .	_____	_____
2. Benches and machines well arranged . . . . .	_____	_____
3. Tools and equipment in good repair . . . . .	_____	_____
4. Bulletin board material well arranged and changed frequently . . . . .	_____	_____
5. Teacher's desk in order . . . . .	_____	_____
6. A metal container for oily rags . . . . .	_____	_____
7. Machines oiled regularly . . . . .	_____	_____

FOREMAN		
1. Machines cleaned properly . . . . .	_____	_____
2. Storage room well kept . . . . .	_____	_____
3. Tools—clean, in racks, and all accounted for . . . .	_____	_____
4. Blackboard clean . . . . .	_____	_____
5. Supply room clean and orderly . . . . .	_____	_____
6. Floor cleaned daily . . . . .	_____	_____
7. Books, pamphlets, blueprints—clean and well ar- ranged . . . . .	_____	_____
8. Lockers kept orderly . . . . .	_____	_____
9. Projects stored in good order . . . . .	_____	_____
10. Sink clean . . . . .	_____	_____
11. Clean-up tools in proper place . . . . .	_____	_____

# 5 Instructional Aids\_\_\_\_\_

## BOOKS, MAGAZINES, FILMS



IN A BULLETIN OF THIS KIND it is impossible to list all of the instructional materials in the form of books, pamphlets, study guides, charts, etc. Many teachers may be using excellent instructional aids not included here. This listing is not exhaustive.

Certain instructional materials are listed, however, with author, publisher, address of publisher, and an annotation of the contents, so that the Industrial Arts teacher will know what phase of instruction is included in each reference.

### BOOKS

Atlas Press, *Manual of Lathe Operations and Machinists Tables*. Kalamazoo, Mich., 1937, 240 pp., \$1.25

This book covers the theory of metal cutting, machining of metals, lathe operations and attachments, care and construction of the lathe together with a series of machinists' tables.

Burghardt, Henry D., *Machine Tool Operations, Part I*. New York, N. Y., McGraw-Hill Book Company, 1941, 420 pp., \$3.20

An elementary treatise on the lathe, bench, and forge work.

Burghardt, Henry D., *Machine Tool Operations, Part II*. New York, N. Y., McGraw-Hill Book Company, 1937, 510 pp., \$3.60

A treatise on the drilling machine shaper, planer, milling and grinding machines.

Delmar Publishers, *Drill Press Work*. Albany 1, N. Y., 1946, 42 pp., \$1.10

The theory and operation of the drill press, use of accessories and holding devices together with cutting speeds and feeds for common drill press operation.

Delmar Publishers, *Industrial Arts—Metal Area Comprehensive General Shop*. Albany 1, N. Y., 1949, 160 pp., \$1.95

A study guide for a selected series of lesson topics in metalwork. These topics include planning, guidance, safety, hygiene, and consumer education.

Delmar Publishers, *Lathe Work*. Albany 1, N. Y., 1946, 164 pp., \$2.00

A treatise of related technical information and instruction covering fundamental lathe operations.

Delmar Publishers, *Milling Machine Work*. Albany 1, N. Y., 1943, 298 pp., \$3.25

Theory and practice of basic and advanced milling machine operations.

Delmar Publishers, *Shaper Work*. Albany 1, N. Y., 1944, 326 pp., \$3.75

A complete treatise on modern crank and hydraulic shapers together with basic and advanced operations and related information.

Felker, C. A., *Machine Shop Technology*. Milwaukee, Wis., Bruce Publishing Company, 1952, 491 pp., \$4.80

A well-illustrated book on the construction, use, and care of the common hand and machine tools.

Grisbook, H., and Phillipson, C., *Pictorial Guide To Machine Shop Practices*. New York, N. Y., Emerson Books, 1944, 91 pp., \$1.25

A series of "picturegrams" illustrating correct and incorrect practices relating to fitting, lathe, drill press, and milling machine work.

Kearney & Trecker Corporation, *Right and Wrong In Milling Practice*. Milwaukee 14, Wis., 1942, 136 pp., \$.50

A series of "picturegrams" illustrating correct and incorrect practices relating to setup, operation, and maintenance of the milling machine; the selection, use, and care of cutters; housekeeping and personal safety.

Kearney & Trecker Corporation, *The Milling Machine and Its Attachments*. Milwaukee 14, Wis., 1945, 83 pp., \$.50

A presentation of the principles and mechanical construction of the milling machine, together with a discussion on attachments, cutters, and accessories.

King, Lewis E., *Lathe Operations*. New York, N. Y., MacMillan Company, 1944, 115 pp., \$.75

This book is designed to assist pupils in learning the fundamental lathe operations and may be used either as a textbook or as a procedure guide in selecting tools and attachments needed in performing the various lathe operations.

King, Lewis E., *Milling Machine Operation*. New York, N. Y., MacMillan Company, 1944, 123 pp., \$.75

Step-by-step instruction and information on the basic milling machine operations.

Knight, Roy E., *Machine Shop Projects*. Bloomington, Ill., McKnight & McKnight Publishing Company, 1943, 112 pp., \$1.20

A book of detailed blueprint projects with a bill of materials and an operation time sheet for each one.

R. K. LeBlond Machine Tool Company, *Running A Regal*. Cincinnati, O., 1951, 89 pp., \$.50

A manual of lathe operations and maintenance of a geared-head engine lathe.

Ludwig, O. A., *Metalwork Technology and Practice*. Bloomington, Ill., McKnight & McKnight Publishing Company, 1947, 397 pp., \$4.40

A complete textbook for hand and machine metalwork. It describes tools, materials, and operations common to metalworking occupations.

Oberg, Erik, and Jones, F. D., *Machinery's Handbook*. New York, N. Y., Industrial Press, 1941, 1815 pp., \$7.00

A reference book on machine shop practice.



Sheldon Machine Co., *The Care and Operation of the Lathe*. Chicago, Ill., 1942, 106 pp., \$.50

This book presents the essential "do's and don'ts" for lathe operators with complete tool-grinding charts.

Shuman, John T. and Bardo, Lewis H., *How To Operate A Lathe*. New York, N. Y., John Wiley & Sons, 1944, 161 pp., \$2.50

A question and answer book to assist pupils in understanding the operation of the lathe.

Shuman, John T., and others, *Machine Shop Work*. Chicago, Ill., American Technical Society, 1947, 592 pp., \$3.75

A comprehensive treatise on approved machine shop methods including construction and use of tools and machines.

Smith, Robert T., *Machining of Metal*. Bloomington, Ill., McKnight & McKnight Publishing Co., 1949, 224 pp., \$3.50

Instruction on the operation and care of the drill press, engine lathe, shaper, milling machine, grinding machines, power hack saw, and the metal-cutting band saw, with illustrations on safety precautions and the proper use of tools.

South Bend Lathe Works, *How to Run A Drill Press*. South Bend 22, Ind., 1951, 31 pp., \$.25

This book presents the essential, practical, and related information required to operate a drill press.

South Bend Lathe Works, *How To Run A Lathe*. South Bend 22, Ind., 1950, 128 pp., \$.25

Designed especially for beginners, this book presents the essential, practical, and related information required to run a lathe.

South Bend Lathe Works, *How To Run A Metalworking Shaper*. South Bend 22, Ind., 1952, 32 pp., \$.50

This book presents the essential, practical, and related information required to operate the metal-working shaper.

South Bend Lathe Works, *The South Bend Machine Shop Course*. South Bend 22, Ind., 1951, 32 pp., \$.50

A series of twelve lathe projects for beginners in lathe work, with working drawings and operation sheets.

Telford, Arthur C., *Dictionary of Machine Shop Terms*. Chicago 37, Ill., American Technical Society, 292 pp., \$.75

This book defines for the pupil thousands of words and terms used in metal machining.

Whipple, G. G., and Baudek, A. C., *Engine Lathe Operations*. Bloomington, Ill., McKnight & McKnight Publishing Company, 1942, 160 pp., \$1.80

Fundamental lathe operations presented in logical sequence, with a concise explanation of the construction of the lathe, and special emphasis on its care.

## SAFETY BOOKS AND PAMPHLETS

Allis-Chalmers Manufacturing Company, *Grinding Practices*. 1126 South 70th St., Milwaukee, Wis., 1949, 20 pp., free

A handbook of safe practices for shop grinding operations.

Allis-Chalmers Manufacturing Company, *Grinding Standards*. 1126 South 70th St., Milwaukee, Wis., 1949, 32 pp., free

Standards and responsibilities for various grinders and grinding operations.

American Standards Association, *American Standard Safety Code for the Use, Care and Protection of Abrasive Wheels*. 29 West 39th Street, New York, N. Y., 1943, 62 pp., \$.25

Standards for the use, care, and protection of abrasive wheels.

American Standards Association, *Use, Care, and Protection of Abrasive Wheels*. 29 West 39th Street, New York, N. Y., 1943, 61 pp., \$.35

A safety code for the use, care, and protection of abrasive wheels.

Association of Casualty & Surety Companies, *Education for Safety Through the School Shop*. New York, N. Y., 1952, 109 pp., \$1.25

A program of shop safety planned to integrate safety with instruction.

Best Company, *Safety Directory*. 75 Fulton Street, New York 7, N. Y., 1946, 351 pp., \$.50

A directory of safety, hygiene, first-aid and fire-protection equipment.

Blake, R. P., *Industrial Safety*. 70 Fifth Avenue, New York 11, N. Y., Prentice-Hall, 1943, 435 pp., \$6.00

An excellent analysis of the principles of industrial safety.

Board of Education of the City of New York, *School Shop Safety Manual*. 110 Livingston Street, Brooklyn 2, N. Y., 1948, 244 pp., free

Safety rules and approved practices for the shops of the New York City schools.

Bureau of Mines, U. S. Government Printing Office, *Manual of First Aid Instruction*. Washington 25, D. C., 1930, 361 pp., \$.45

The textbook of instruction used by the Bureau of Mines in their first-aid course of instruction.

Delmar Publishers, *Shop Safety Education*. Orange Street and Broadway, Albany 7, N. Y., 1949, 319 pp., \$.30

Principles of accident prevention in the home, in the school shop, in industry, and on the farm.

Department of Labor, *Lifting Heavy Weights In Industry*. Women's Bureau, Washington 25, D. C., 1941, 11 pp., \$.05

This bulletin illustrates and explains various methods for conserving the health of workers and describes how to lift heavy weights without injury.

Devoe & Reynolds Company, *Color Comfort*. 787 First Avenue, New York 17, N. Y., 10 pp., free

The story of eye comfort as enjoyed through the use of color.

DuPont deNemours & Company, *Three Dimensional Seeing*. 1616 Walnut Street, Philadelphia, Pa., 14 pp., free

The story of the science of color and light for better vision in industry.

Gardiner, Glenn L., *How To Prevent Accidents*. Elliott Service Company, 30 North MacQuesten Parkway, Mt. Vernon, N. Y., 1949, 11 pp., \$.20.

An outline of the fundamentals of accident prevention.

Graman, H. R., *A Good Mechanic Seldom Gets Hurt*. 848 E. 58th Street, Chicago, Ill., American Technical Society, 1943, 95 pp., \$.75

Information on personal, tool, and machine safety in the various metal-working areas.

Greater Cleveland Safety Council, *Shop Safety*. Cleveland, O., 1947, 27 pp., \$.60

A complete program of school shop safety.

Heinrich, H. W., *Industrial Accident Prevention*. McGraw-Hill Book Company, 330 West 40th Street, New York, N. Y., 470 pp., \$6.00.

An explanation of the principles, facts, and methodology of accident prevention.

- Metropolitan Life Insurance Company, *First Aid*. 1 Madison Ave., New York, N. Y., 1950, 33 pp., free  
Instruction on what to do while waiting for the doctor.
- Metropolitan Life Insurance Company, *Industrial Safety*. 1 Madison Avenue, New York, N. Y., 153 pp., free  
A serial presentation of industrial safety principles and their application.
- Metropolitan Life Insurance Company, *Industrial Safety Education In Schools*. 1 Madison Avenue, New York, N. Y., 48 pp., free  
A discussion of principles and practices upon which effective safety education in school shops is based.
- Michigan State Board of Control for Vocational Education, *Training for Safety*. 115 West Allegany Street, Lansing, Mich., 1942, 155 pp., free  
A safety training program for school shops.
- Missouri Department of Education, Division of Public Schools, *Safety Education in Industrial Arts Departments*. 1947, 6 pp., free  
A handbook of safety instruction for the Industrial Arts department.
- National Conservation Bureau, *Handbook of Industrial Safety Standards*. 60 John Street, New York 7, N. Y., 1942, 132 pp., free  
A compilation of generally recognized industrial safety requirements.
- National Safety Council, *Safety Education in the School Shop*. 422 North Michigan Avenue, Chicago 1, Ill., 1946, 64 pp., \$.50  
A guide for teachers, supervisors, and administrators in providing training that will meet the safety requirements of industry for which workers are being trained.
- National Safety Council, Inc., *Shop Safety*. 422 North Michigan Avenue, Chicago 11, Ill., 1945, 32 pp.  
A series of safety hints for users of tools.
- Norton Company, *A Primer on Grinding Wheel Safety*. 52 New Bond Street, Worcester 6, Mass., 1941, 24 pp., free  
A brief presentation of important safety facts for grinder operators.
- Pennsylvania Department of Labor and Industry, *Safe Practices Recommendations*. Harrisburg, Pa., 1942, 51 pp., free  
Safe practices and recommendations for industrial workers.
- Pennsylvania Department of Public Instruction, Bulletin 332, *Safety Education In Industrial Schools*. Harrisburg, Pa., 1938, 87 pp., free  
A study of accidents in school shops, their causes, and recommendations of approved procedures for reducing them.
- Pennsylvania Department of Public Instruction, Bulletin 399, *A Program of Fire Prevention in Schools*. Harrisburg, Pa., 1951, 180 pp., \$.50. Free to Pennsylvania school administrators for distribution to teachers.  
A manual of instruction for use of teachers of students of all grades in the public and private schools, with regard to the dangers of fire and the prevention of fire waste. Included is a chapter on fire safety in the school shop.
- Philadelphia School District, *Education for Safety*. Benjamin Franklin Parkway at Twenty-first Street, Philadelphia, Pa., 1945, 218 pp., free  
A program of school safety from the kindergarten through the high school.
- Pittsburgh Plate Glass Company, *Color Dynamics*. Grant Building, Pittsburgh 19, Pa., 37 pp., free  
Application of color dynamics to industry.

- Scranton Public Schools, Department of Industrial Education, *Safety Education*. Scranton, Pa., 1949, 29 pp., free  
A manual for the study of safe practices in shopwork.
- Sherwin-Williams Company, *Color Harmony Suggestions*. 101 Prospect Avenue, Cleveland, O., 27 pp., free  
Suggestions on how sight is affected by color harmony in offices and schools.
- South Rochester Board of Education, *Safety for Workers in Machine Shops*. 13 Fitzhugh Street, South Rochester, N. Y., 1943, 68 pp., free  
A program of machine shop safety.
- South Rochester Board of Education, *Tentative Course of Study in Safety Education*. 13 Fitzhugh Street, South Rochester, N. Y., 1940, 68 pp., free  
A course of study in safety education for tenth-grade students.
- Tatio, Earl E., *Safety Instruction for Machine Shop Practices*. Board of Education, 13 Fitzhugh Street, South Rochester, N. Y., 1940, 25 pp., free  
A course in machine shop safety for industrial education students.
- Thornburg, M. D., *Safe Practices For Machine Shops*. North Carolina State Department of Public Instruction, Department of Trade and Industrial Education, Raleigh, N. C., 1945, 22 pp.  
A manual of safe practices for machine shop instructors.
- Travelers Insurance Company, *Handbook of Industrial Safety Standards*. 700 Main Street, Hartford, Conn., 1945, 212 pp., free  
A compilation of generally recognized industrial safety requirements.
- Travelers Insurance Company, *Use and Care of Hand Tools*. 700 Main Street, Hartford, Conn., 1944, 30 pp., free  
A handbook on the use and care of hand tools.
- Trenton Public Schools, Industrial Arts Department, *Safety Education for the Industrial Arts Department*. Trenton, N. J., 23 pp., free  
A safety program for Industrial Arts shops.
- West Virginia State Department of Education, Vocational Division, *Safety Handbook*. Charleston, W. Va., 1942, 42 pp., free  
A safety handbook for beginners in vocational industrial education.
- Wisconsin State Board of Vocational and Adult Education, *Machine Shop Safety Training*. Madison, Wisconsin, 1944, 17 pp., free  
A safety program for the school machine shop.

### FREE PAMPHLETS

- Abrasive Company, *Grinding Wheel Data Book*. Tacony and Fraley Streets, Philadelphia, Pa., 112 pp.  
A handbook on grinding wheel specifications.
- Aluminum Company of America, *Machining Alcoa Aluminum*. 1922 Gulf Building, Pittsburgh 19, Pa., 47 pp.  
Description of the cutting tools best fitted for machining aluminum and its alloys, together with a discussion of the cutting speeds and feeds, grinding wheels, and data on automatic screw-machine practice.
- Barnes Company, W. O., Inc., *Manual of Metal Cutting Information*. 1299 Terminal Avenue, Detroit 14, Mich., 40 pp.  
The correct use of hand- and power-operated hack saws together with causes of common difficulties are well described in this book.



- John Bath & Company, Inc., *Dr. Bath, Specialist in Tapping Diseases*. 18 Grafton Street, Worcester, Mass., 38 pp.  
 Practical information in regard to the uses and selection of the correct taps and machine condition for threading different metals.
- Besly Company, Charles H., *Handbook for Users of Taps*. 118-124 North Clinton Street, Chicago 6, Ill., 18 pp.  
 Information on how to select, use, and maintain taps, and tables of thread dimensions and tap drill sizes.
- Carborundum Company, *Causes and Correction of Common Grinding Errors*. 44 S. Portage Road, Niagara Falls, N. Y., 8 pp.  
 An explanation of the causes and corrections of common grinding errors.
- Chase Brass and Copper Company, *Chase Dictionary of Brass and Copper Terms*. 1939 Plant Street, Waterbury 91, Conn., 91 pp.  
 Brief and nontechnical explanations of terms used in ordering or describing brass and copper.
- Cincinnati Shaper Company, *Setups on Cincinnati Shapers*. Hopple, Garrard & Elm Streets, Cincinnati, O., 12 pp.  
 A presentation of fundamentals in shaper setups.
- Cleveland Twist Drill Company, *Handbook for Drillers*. 1242 East 49th Street, Cleveland 14, O., 48 pp.  
 General description of the twist drill with illustrations in detail; its care, and operation.
- Delta File Company, *Files, How to Select and Conserve Them*. 4839 James Street, Philadelphia, Pa., 28 pp.  
 A brief course of instruction in the proper selection, use, and care of files.
- Graton and Knight Company, *Belting Manual*. 356 Franklin Street, Worcester, Mass., 195 pp.  
 A handbook on leather belting.
- Landis Tool Company, *Better Grinding*. Sixth and Ringgold Streets, Waynesboro, Pa., 89 pp.  
 The art of successful grinding is condensed into a series of statements or rules for doing a consistently good job.
- Macklin Company, *Helpful Hints*. Wildwood Road, Jackson, Mich., 64 pp.  
 Safety suggestions on the use of grinding wheels.
- Morse Twist Drill and Machine Company, *Machinist's Practical Guide*. 163 Pleasant Street, New Bedford, Mass., 60 pp.  
 A pocket-size booklet containing decimal equivalents of drill sizes, tap sizes, reamer sizes, speeds and feeds of drills, cutting speeds, thread dimensions, weights of steel bars, and formulas for finding dimensions of circles and squares.
- Norton Company, *A Primer on Grinding Wheel Safety*. 3 New Bond Street, Worcester 6, Mass., 24 pp.  
 A brief presentation of important safety facts for the grinder operator.
- Norton Company, *How to Use Truing and Dressing Tools for Better Grinding*. 3 New Bond Street, Worcester 6, Mass., 20 pp.  
 A treatise on truing and dressing grinding wheels.
- Norton Company, *Tool and Cutter Grinding*. 3 New Bond Street, Worcester, Mass., 117 pp.  
 A handbook of tool and cutter grinding.
- Nicholson File Company, *File Philosophy*. 93 Acorn St., Providence, R. I., 47 pp.  
 A brief account of the history, manufacture, variety, and uses of files in general.



Simonds Abrasive Company, *Grinding Wheel Data Book*. Tacony and Fraley Streets, Philadelphia 37, Pa., 128 pp.

A compilation of data most commonly used in the field of grinding.

Simonds Saw and Steel Company, *Hacksawology*. Squier and Parker Streets, Fitchburg, Mass., 24 pp.

Helpful hints on the care and use of hack-saw blades.

Simonds Saw and Steel Company, *Hack Saws and How to Use Them*. Squier and Parker Streets, Fitchburg, Mass., 31 pp.

Simple instruction on how to use the hack saw.

Skinner Chuck Company, *Chucks and Their Uses*. 344 Chuck Street, New Britain, Conn., 79 pp.

Instruction on the care and use of chucks.

South Bend Lathe Works, *Leveling the Lathe*. 425 East Madison Street, South Bend 22, Ind., 32 pp.

Detailed information on installing and leveling of the lathe.

### FREE PERIODICALS

American Iron and Steel Institute, *Steelways*. 350 Fifth Avenue, New York, N. Y. Bimonthly.

Latest developments in the steel industry, and historical stories of the development of the steel industry.

American Mutual Liability Insurance Company, *Watch*. 143 Berkeley Street, Boston 16, Mass. Quarterly.

A publication to assist individuals in eliminating accident hazards in the home and in driving an automobile.

Do All Company, *Production News*. Des Plaines; Ill. Monthly.

Timely tips on "Do All" band saws, other cutting machine tools, gauges, and cutting tools.

Gardner Publications, *Modern Machine Shop*. 431 Main Street, Cincinnati, O. Monthly.

A magazine devoted to modern machine shop practices, with a list of machine tool equipment advertisements by leading manufacturers.

Gardner Publications, *Products Finishing*. 431 Main Street, Cincinnati, O. Monthly.

Modern production finishing with a list of finishing machines and equipment advertisements by leading manufacturers.

Geometric Tool Company, *Threads*. 10 Valley Street, New Haven, Conn. Monthly.

The latest developments in screw threads.

Harrison Abrasive Corporation, *Harrison Abrasive Magazine*. Box 66, Manchester, N. H. Monthly.

The latest developments in the abrasive field.

Maintenance Publishing Company, *Industrial Maintenance*. 3623-27 Filbert Street, Philadelphia 4, Pa. Monthly.

News about new products, equipment, materials, literature, and ideas for industrial maintenance, production, and operation.

National Machine Tool Builders Association, *Machine Tools*. 10525 Carnegie Avenue, Cleveland, O. Monthly.

Latest developments in machine tools.

Norton Company, *Grits and Grinds*. 3 New Bond Street, Worcester, Mass. Monthly.

A technical house organ, devoted to the interests of better grinding, lapping, and surface finishing.

Oakite Products, *Oakite News*. 20 Thames Street, New York 6, N. Y. Bimonthly.  
Latest developments in the cleaning field.

Reynolds Metal Company, *Aluminum Reporter*. 2576 South Third Street, Louisville 1, Ky. Periodically.

The latest information on uses and developments in aluminum.

Reynolds Metal Company, *Technical Advisor*. 2500 South Third Street, Louisville, Ky. Monthly.

Covers the latest methods for fabricating and processing aluminum and its alloys.

Standard Safety Equipment Company, *Sta-Safe News*. 234 West Ontario Street, Chicago, Ill. Bimonthly.

A bulletin devoted to the latest industrial safety developments.

Sterling Grinding Wheel Division, *Sterling Sparks*. Tiffin, O. Monthly.

Latest developments in the grinding field.

Thomas Publishing Company, *Industrial Equipment News*. 461 Eighth Avenue, New York, N. Y. Monthly.

A monthly publication devoted to what's new in equipment, parts, and materials.

## MAGAZINES

Alfred Best Company, *Safety Engineering*. 75 Fulton Street, New York 7, N. Y. Monthly. \$4.00 per year

Covers accident prevention, safety, occupational disease control, and fire prevention.

American Standards Association, *Industrial Standardization and Commercial Standards*. 20 W. 29th Street, New York, N. Y. Monthly. \$4.00

A periodical devoted to machine standards and practices.

Bruce Publishing Company, *Industrial Arts and Vocational Education*. 400 North Broadway, Milwaukee, Wis. Monthly. \$3.00 per year

A professional magazine for the teacher of practical arts.

Conover-Mast Corporation, *Mill and Factory*. 205 East 42nd Street, New York, N. Y. Monthly. \$5.00 per year

Information on management, production, and maintenance.

Fawcett Publishing Company, *Mechanics Illustrated*. Fawcett Building, Greenwich, Conn. Monthly. \$1.80 per year

Covers crafts, hobbies, and home workshop activities.

Greater New York Safety Council, *Safety*. 60 East 42nd Street, New York, N. Y. Monthly. \$2.00 per year

Devoted primarily to industrial safety, but containing, also, a monthly safety lesson plan for shop teachers.

Industrial Ledger, *Industrial Ledger*. Ledger Building, Tenafly, N. J. Monthly. \$3.00 per year

A clearing house of industrial information.

Industrial Press, *Machinery Magazine*. 148 Lafayette T., New York, N. Y. Monthly. \$4.00 per year

A general reference magazine of shop practices and industrial trades.

Industrial Publishing Company, *Occupational Hazards*. 812 Huron Road, Cincinnati, Ohio. Monthly. \$3.00 per year

Devoted to the engineering control of occupational hazards, such as dusts, fumes, vapors, organic solvents, dermatitis, industrial sanitation, machine accidents, and industrial health and safety.

Iron Age Publishing Company, *The Iron Age*. 239 W. 29th Street, New York, N. Y. Weekly. \$8.00 per year

A reference magazine on welding, cutting, machining, forging, stamping, heat-treating and news of the metalworking industry.

*Light Metal Age*. 201 N. Wells Street, Chicago 6, Ill. Bimonthly. \$3.00 per year

Devoted to production, fabrication, application, and design of magnesium, aluminum, beryllium, and light alloys.

Lightner Publishing Company, *Automatic Age*. 2810 Michigan Avenue, Chicago, Ill. Monthly. \$1.00

Devoted to automatic devices found in machine developments.

Lightner Publishing Corporation, *Hobbies*. 2810 South Michigan Avenue, Chicago 16, Ill. Monthly. \$3.50 per year

Information on a large variety of hobbies and sources of hobby materials.

McGraw-Hill Publishing Company, *American Machinist Magazine*. 330 W. 52nd Street, New York, N. Y. Bimonthly. \$5.00 per year

A general information magazine pertaining to shop and trade practices.

McGraw-Hill Publishing Company, *Factory Management and Maintenance*. 330 W. 42nd Street, New York, N. Y. Monthly. \$3.00 per year

Maintenance and factory service and employe relations. Includes what is new in equipment and short cuts in service problems.

Modern Metals Publishing Company, *Modern Metals*. 206 S. Michigan Avenue, Chicago 4, Ill. Monthly. \$3.00 per year

Devoted to latest developments in light metals.

National Safety Council, *Safety Education*. 20 North Wacker Drive, Chicago 6, Ill. Monthly. \$3.00 a year

A magazine on school safety for teachers and administrators.

Penton Publishing Company, *Machine Design*. 1213 West Third Street, Cleveland, Ohio. Monthly. \$6.00 per year

Covers discussions of parts, materials, accessories, and finishes in their application to machine design.

*School Shop*. 330 South State Street, Ann Arbor, Mich. Monthly. \$2.00 per year

Devoted to school shop projects.

*Tool and Die Journal*. 1975 Lee Road, Cleveland 18, Ohio. Monthly. \$4.00 per year

Devoted to designing, building, and using precision tools in tool and die making.

U. S. Department of Labor, *Labor Information Bulletin*. Bureau of Statistics, 14th Street and Constitution Avenue, Washington, D. C. Monthly. \$.75 a year

Information on labor conditions.

## FREE CHARTS

*Brown & Sharpe Universal Bevel Protractor Readings*. Brown & Sharpe Manufacturing Company, 237 Promenade Street, Providence, R. I. 20" x 27½"

How to read the universal bevel protractor.

*Choosing and Using Files*. Henry Disston & Sons, 1238 Tacony Street, Philadelphia 35, Pa. 17" x 22"

How to use files for various types of filing.

*Common Jacobs Chuck Abuses*. Jacobs Manufacturing Company, 240 West Hartford Street, Hartford, Conn. 8½" x 11"

The symptoms, cause, and cure for common drill chuck abuses.

- Correct Method of Lifting.* Maryland Casualty Company, 701 W. 40th Street, Baltimore, Md. 8½" x 11"  
Correct method of lifting.
- Decimal Equivalents.* National Twist Drill and Tool Company, 6522 Brush Street, Detroit, Mich. 17" x 23"  
Decimal equivalents of fractional parts of an inch, and tap drill sizes.
- Decimal Equivalents of Wire, Letter and Fractional Size Drills.* Whitman & Barnes, 2108 West Fort Street, Detroit, Mich. 16½" x 25¾"  
Decimal equivalents of wire, letter, and fractional sizes of drills, and tap drill sizes for national standard screw threads.
- Dresser Guide.* Desmond-Stephan Manufacturing Company, 173 South Walnut Street, Urbana, Ohio. 9" x 12"  
Illustrates and describes the selection and application of grinding wheel dressing tools.
- Dressing and Truing.* Carborundum Company, 445 Portage Road, Niagara Falls, N. Y. 22⅜" x 35"  
Illustrates when an abrasive wheel needs truing and when it needs dressing.
- A Guide for the Proper Choice of Cutting Tools.* General Tool and Die Company, 555 Prospect Street, East Orange, N. J. 12" x 35"  
Various cutting tools used in machining various metals.
- Guide for Spark Testing Tool Steel.* Carpenter Steel Company, 131 Bern Street, Reading, Pa. 21" x 32"  
Shape, average length, and activity of the sparks of various kinds of carpenter tool steel.
- Lathe Tool Bit Shapes.* Logan Engineering Company, 4901 W. Lawrence Street, Chicago 30, Ill. 17" x 22¼"  
Standard lathe tool shapes and their grinding angles.
- Machining Chart.* Aluminum Company of America, 801 Gulf Building, Pittsburgh 19, Pa. 14" x 20"  
Proper rake angles, correct tools, cutting speeds, feeds, and types of cutting compounds for machining aluminum.
- Machine Screws.* Machinery, 148 Lafayette Street, New York, N. Y. 27" x 17½" x 29½"  
Various dimensions for coarse- and fine-thread machine screws.
- Regal Lathe.* R. K. LeBlond Machine Tool Company, Madison and Edwards Roads, Cincinnati, Ohio. 27" x 41½"  
Nomenclature of the Regal lathe.
- Saw Blade Chart.* Victor Saw Works, 10 Cottage Place, Middletown, N. Y. 17" x 22"  
Proper hand, band, or power saw blade to use for cutting any metal; correct and incorrect methods of using a metal-cutting saw blade; and how to overcome common metal-cutting troubles.
- Tap Drill Sizes.* South Bend Lathe Works, 479 East Madison Street, South Bend 22, Ind. 13" x 19"  
Tap drill sizes for national coarse, fine, and special thread sizes.
- Use the Right File.* Nicholson File Company, 93 Acorn Street, Providence, R. I. 9½" x 10½"  
Correct use of hand files.



## TECHNICAL FILMS

[All films 16mm. sound, black and white, unless otherwise indicated.]

### Abrasives and Grinding

*Cutter Sharpening.* Norton Company, 1 New Bond Street, Worcester 6, Mass. 14 min. Loan.

Demonstrates typical tool and cutter grinding machine with close-up showing operations for grinding commonly used tools.

*Cylindrical Grinder.* Norton Company, 1 New Bond Street, Worcester 6, Mass. 20 min. Loan.

Points out operating levers, hand wheels, push buttons that control the movement of wheel, head, table; and work of cylindrical grinding machine.

*First Principles in Grinding.* Carborundum Company, Niagara Falls, N. Y. 20 min. Loan.

Demonstrates principles of grinding.

*Grinding a Parallel Bar, Part I: Setting up the Machine.* PRI-38MW.\* 14 min. Loan.

How to mount a grinding wheel, position the diamond tool and true the wheel, how to operate a magnetic chuck, use the controls of the grinder, and grind the face of the chuck.

*Grinding a Parallel Bar, Part II: Grinding Operations.* PRI-39MW.\* 15 min. Loan.

How to position the parallel bar on the chuck, rough-grind the opposite sides of the bar, rough-grind adjacent sides of the bar at exact right angles; and finish all four sides.

*Grinding a Plain Pin, Part I: Grinding Wheel.* PRI-40MW.\* 17 min. Loan.

The cutting action of a grinding wheel, how to select the correct grinding wheel, handle and mount the wheel on the collet, true and balance the wheel.

*Grinding a Plain Pin, Part II: Grinding Operations.* PRI-41MW.\* 17 min. Loan.

How to lubricate and set up a center-type grinder, prepare the workpiece for grinding, mount and adjust the workpiece for proper tension between centers, set the table reversing dogs, and rough-grind a plain pin.

*Grinding a Straight Hole.* PRI-42MW.\* 18 min. Loan.

How to use a universal chuck, true up the work with a dial indicator, select the proper grinding wheel and adjust the wheel speed, set the length of stroke, set the cross-feed for automatic grinding, and use the precision cross-feed for finish grinding.

*Grinding a Taper.* PRI-43MW.\* 19 min. Loan.

How to prepare an arbor for grinding, mount and adjust the arbor between centers, adjust the swivel table and taper scale, rough and finish-grind the taper, and check the taper ring gauge and the light gauge.

*Grinding a V-Block.* PRI-45MW.\* 22 min. Loan.

How to set up a V-block to grind the ends and the V, rough and finish-grind the ends; establish reference points for grinding the V to precision measurements, and check for accuracy and parallelism.

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\* Films indicated by PRI letters are available from Pennsylvania State Teachers Colleges located at Bloomsburg, California, Edinboro, Indiana, Lock Haven, Millersville, Slippery Rock, and West Chester, for transportation costs only. Schools should address the closest Teachers College. Films should be ordered according to directions on page ix of *Audio-Visual Aid Catalog*, Department of Public Instruction, Bulletin 208, and its supplements.



*Grinding Practices.* Dartnell Corporation, 4660 Ravenswood Avenue, Chicago, Ill. or University of Illinois, Visual Aids Service, Urbana, Ill. 10 min. Rental.

The theory of grinding rates, feeds, and abrasives in the grinding of special jobs, such as forming and threading.

*Grinding Wheel—Its Care and Use.* Norton Company, 1 New Bond Street, Worcester 6, Mass. 17 min. Loan.

Shows mounting, balancing a new wheel, truing it for desired finish, cause of surface imperfections, checking wheel speeds, care in storing and handling.

*Grinding Wheel Markings.* Norton Company, 1 New Bond Street, Worcester 6, Mass. 18 min. Color. Loan.

Studies a typical grinding wheel marking, giving the meaning of each symbol. After method of marking is analyzed, numerals and letters are considered in terms of abrasive, grain size, grade, structure, and bonding process.

*Grinding Wheel Safety.* Norton Company, 1 New Bond Street, Worcester 6, Mass. 20 min. Color. Loan.

Illustrates safe and unsafe practices in handling of grinding wheels. Shows how grinding wheels are often damaged by careless usage, the hazards involved in using unequal or worn flanges, and other demonstrations of dangerous practices.

*Manufactured Abrasives.* Carborundum Company, Niagara Falls, N. Y. 24 min. Loan.

Shows experiment that led to the discovery of carborundum and use of power generated from Niagara Falls in the manufacture of abrasive products. Depicts making of carborundum, making of grinding wheels by the vitrified process, and illustrates some of the uses of manufactured abrasives.

*Manufacture of Coated Abrasives.* Behr-Manning Corporation, Division of Norton Company, Troy, N. Y. 45 min. 16mm., silent, color. Loan.

The manufacture of abrasive papers and wheels.

*Norton Abrasives in Tool Grinding.* Norton Company, 1 New Bond Street, Worcester 6, Mass. 10 min. Color. Loan.

Operations performed in the toolroom on important machines. Shows setting up for grinding an end mill on a tool and cutter grinding machine.

*Offhand Grinding with Norton Abrasives.* Norton Company, 1 New Bond Street, Worcester 6, Mass. 10 min. Color. Loan.

Operation of removing risers, gates, and pads from castings; billet grinding with swing frame and small portable machines; various grinding jobs with floor stands and bench stands; portable grinders in action—smoothing and cleaning castings.

*Romance of Industry.* (Abrasives), Carborundum Company, Niagara Falls, N. Y. 45 min. 16mm., silent. Loan.

Use of abrasives, manufacture of abrasives, and abrasive products.

*Sharpening an Angular Cutter.* PRI-79MW. See footnote, p. 40. 15 min. Loan.

How to choose the correct grinding wheel, to adjust the swivel table for grinding the angular teeth of the cutter, to adjust for clearance angle when grinding with the periphery of the wheel, and how to check the teeth for accuracy of the angle.

*Sharpening a Form Relieved Cutter.* PRI-75MW. See footnote, p. 40. 18 min. Loan.

Rake angle and clearance angle of the form-relieved cutter; how to mount correct attachment; how to set up for spotting back of teeth and how to grind face of teeth.

*Sharpening a Plain Helical Cutter.* PRI-76MW. See footnote, p. 40. 16 min. Loan.

How to mount the helical cutter on an arbor; how to arrange the four elements in the same horizontal plane; how to grind the secondary clearance angle; and how to check and adjust for taper when grinding the primary clearance angle.

*Sharpening a Side Milling Cutter.* PRI-78MW. See footnote, p. 40. 23 min. Loan.

How to identify the parts of a cutter, select and mount the correct grinding wheel, mount the cutter, set up the grinder for sharpening, set the correct clearance angle, and check for correct width of land.

## **Bench and Hand Work**

*Centering Small Stock.* PRI-4MW. See footnote, p. 40. 12 min. Loan.

How to locate the center of round, square, and rectangular pieces, using surface plate, V-blocks, and surface gauge; hermaphrodite calipers; and center square and rule.

*Cutting Threads With Taps and Dies.* PRI-18MW. See footnote, p. 40. 19 min. Loan.

Methods, operations, and procedures for cutting small threads with hand taps and dies. The correct use of the taper, plug, and bottoming taps in cutting internal threads in a blind hole, and how to use a hand die to cut threads on a stud to fit in the tapped holes.

*Filing.* PRI-31MW. See footnote, p. 40. 15 min. Loan.

Types of files and file cuts, and the importance of filing in machine shop work.

*Files and How to Use Them.* DeFrenes & Company, 1909 Buttonwood Street, Philadelphia, Pa. Slide film, 68 frames. Loan.

Practical instructions on the selection, use, and care of files for the work bench.

*Fundamentals of Filing.* PRI-32MW. See footnote, p. 40. 12 min. Loan.

Shows the various kinds of files and indicates the general type of work for which each is used. Shows the use of single-cut files, draw filing with a single-cut fine file, the difference between the single- and double-cut files; types of files used for different types of jobs and with different metals.

*Hack Saws and How to Use Them.* Simonds Saw & Steel Company, Advertising and Publicity Department, Fitchburg, Mass. 29 min. Color. Loan.

Steps in use of hand and power hack-saw blades; proper selection of blades; and approved methods of operation for greatest efficiency and longest blade life.

*Hacksaws.* Plomb Tool Company, 2209 Santa Fe Avenue, Los Angeles 54, Calif. 18 min. Loan.

How to select the proper blades for various metals, and correct methods of use.

*Laying Out Small Castings.* PRI-52MW. See footnote, page 40. 16 min. Loan.

Methods and procedures for laying out holes for drilling; how to locate a reference point; and the use of the hermaphrodite calipers, combination square, and surface gauge.

*Reaming With Straight Hand Reamers.* PRI-67MW. See footnote, p. 40. 20 min. Loan.

How to drill and machine-ream two holes in line and how to finish the hole to size, using a straight-fluted reamer. Shows the reamer, names its parts, describes cutting angles, and explains its cutting action. Shows how to use a helical-fluted reamer in reaming a hole in a gear blank having a keyway.

*Reaming With Taper Hand Reamers.* PRI-68MW. See footnote, p. 40. 15 min. Loan.

Demonstrates hand-reaming of a taper pin hole through a shaft and collar; taper-reaming of a dowel pin hole in a split bearing to maintain alignment between the bearing cap and the bearing base, and the action of a reamer in removing metal.

*Use and Care of Hand Files.* PRI-89MW. See footnote, p. 40. 11 min. Loan.

Identifies various types of files and their parts; shows correct movements and positions and uses of files; explains cleaning and caring for files.

## **Drill Press**

*Basic Machines—The Drill Press.* PRI-21MW. See footnote, p. 40. 10 min. Loan.

Principal parts of the drill press; how to operate a simple drill press; other types of drill presses and their uses.

*Countersinking, Counterboring and Spot-Facing.* PRI-8MW. See footnote, p. 40. 20 min. Loan.

Methods and sequences to set up a drill press. The first example is a 3/16th by 2-inch steel plate which must be drilled and countersunk; the second a small cast-iron pedestal, the hub of which must be drilled and counterbored, and the base drilled and spot-faced.

*Drilling a Hole in a Pin.* PRI-22MW. See footnote, p. 40. 10 min. Loan.

Operations and sequences followed to drill a hole in each end of a steel pin. Two methods are shown: drilling to a layout and drilling with a jig. The use of a jig when drilling narrow deep holes is shown. Commentary is used to emphasize safety precautions.

*Drilling to a Layout and Spot-facing a Cast Iron Valve Body.* PRI-27MW. See footnote, p. 40. 15 min. Loan.

Technique used to drill to a layout, and spot-face the under side of a flange. A test spot is drilled. It is badly off center, and the technique used in drawing it over to the center of the layout is demonstrated. The reasons why the drill often starts off center, and the basic reasons underlying the techniques used in drawing it back on center are demonstrated.

*Drilling in Metal, Wood, and Plastics.* PRI-25MW. See footnote, p. 40. 23 min. Loan.

The use of several types of drills suitable for drilling different metals, wood, and plastics.

*Locating Holes, Drilling and Tapping in Cast Iron.* PRI-53MW. See footnote, p. 40. 18 min. Loan.

Methods and sequences followed in drilling and tapping cast iron. Locating the center of the bolt circle and the bolt holes are shown. A tapping chuck of standard make is used to tap two holes for set screws. The method of setting the machine and precautions operator must take are shown in detail.

*Uses and Abuses of Twist Drills.* Cleveland Twist Drill Company, 1242 E. 49th Street, Cleveland, Ohio. 30 min. Loan.

Fundamental principles combined to produce the twist drill, and the proper and improper methods of using it.

## **Lathes**

*Basic Machines—The Lathe.* PRI-51MW. See footnote, p. 40. 15 min. Loan.

How the lathe removes metal; how the work is supported; how power is applied to rotate it; how spindle speeds are changed; how the cutting tool is supported and moved; and how the rate of feed is changed.

*Boring to Close Tolerances.* PRI-2MW. See footnote, p. 40. 17 min. Loan.

How to mount and adjust the brass valve bonnet in a ring fixture; how to select and set boring tools for brass; how to rough and finish-face the hub; how to rough and finish-bore the hole; how to prevent bellmouth when boring a hole; how to use a plug gauge; and how to set inside calipers for close measurement.

*Cutting an External Acme Thread.* PRI-12MW. See footnote, p. 40. 16 min. Loan.

Shows the work being mounted on a mandrel, and placed between centers on the lathe; how to set the lathe gears for cutting a thread and the selecting, checking, and setting up of roughing and finishing tools. Sequences show how to cut thread with and without using the threading dial.

*Cutting an External National Fine Thread.* PRI-13MW. See footnote, p. 40. 12 min. Loan.

Shapes of threads and their uses, characteristics of the National Fine Thread, and procedure used to cut this thread on a lathe, detailed instructions for checking the shape of the threading tool with a gauge, proper setting of the tool for cutting a thread, how to set the lathe for cutting the required pitch. Use of the threading dial is shown in detail.

*Cutting an Internal Acme Thread.* PRI-14MW. See footnote, p. 40. 22 min. Loan.

How to set up the lathe and cut an internal right-hand acme thread, how to grind and check the stocking and forming tools, why the compound rest is set at an angle toward the headstock when cutting a right-hand internal thread, how the finish-forming tool is centered in the groove formed by the stocking tool, how to set the threading tools to the work, and how to gauge the finished threads.

*Cutting a Taper With the Compound Rest and With a Taper Attachment.* PRI-11MW. See footnote, p. 40. 11 min. Loan.

The correct method of setting the compound rest to cut a steep taper, and how to set the taper attachment for cutting a taper of  $1\frac{1}{2}$ " per foot; the correct use of roughing and finishing tools; and the use of the bevel protractor and ring gauge to measure tapers.

*Drilling, Boring and Reaming Work Held in Chuck.* PRI-24MW. See footnote, p. 40. 11 min. Loan.

Cutting a tapered hole in a forged steel gear blank using the taper attachment. Centering the piece in a chuck, rough-facing, drilling, taper-boring and reaming are detailed. A taper plug gauge is used to check the size and taper of the finished hole.

*Elementary Operations on the Engine Lathe.* Encyclopaedia Britannica Films, 20 North Wacker Drive, Chicago, Ill. 22 min. Rental-Loan.

Modern shop practices, correct alignment of lathe showing details in facing, straight-turning, square a shoulder, working accurately to dimensions from a drawing, and use of micrometers with graduated dials.

*How to Run a Lathe.* South Bend Lathe Works, 425 E. Madison Avenue, South Bend 22, Ind. 60 min. Color. Loan.

Technique of turning work between centers; blueprints, measuring, centering, rough-turning and finishing.

*Lathe Operation.* University of Illinois, Urbana, Ill. 20 min. Rental-Loan.

Lathe turning, grinding, cutting, boring, tapering and facing. Principles of a lathe, its parts and accessories.

*Lathes—Part I.* PRI-FS-1MW. See footnote, p. 40. Slide films, 59 frames. Loan.

Lathe construction, parts, function, and holding work. *Part II.* 46 frames. Loan. Operations performed on the lathe, its care and safety hints.



*Machining Work Held in Chuck—Use of Reference Surfaces.* PRI-56MW. See footnote, p. 40. 24 min. Loan.

How to set up a workpiece accurately to the reference surfaces in a lathe chuck, and how to use a boring bar to machine several internal surfaces.

*Metal Working Lathe, The.* South Bend Lathe Works, 425 E. Madison Avenue, South Bend 22, Ind. 20 min. Color. Loan.

The metal lathe, its uses, its operation and a demonstration of turning, facing, and thread-cutting.

*Plain Turning.* South Bend Lathe Works, 425 E. Madison Avenue, South Bend 22, Ind. 20 min. Color. Loan.

Companion film to *Metal Working Lathe* (listed above). Operations in machining a shaft between lathe centers. Basic procedures, blueprint reading, measuring with calipers, micrometers, locating and drilling center holes, selection of tools for cutting, rough-turning and finish-turning of workpiece.

*Precision at Work.* Monarch Machine Tool Company, Sidney, O. 45 min. 16 mm., silent. Loan.

Operation of the precision lathe and its construction. Shows accuracy necessary to achieve precision in manufacture.

*Rough Turning Between Centers.* PRI-70MW. See footnote, p. 40. 15 min. Loan.

How to set up an engine lathe for machining work held between head and tail centers. Emphasizes safety precautions in dress and work, necessity for constant reference to the blueprint, lubrication of the machine, care of the centers, and proper use of the various lathe controls.

*Turning a Taper With the Tailstock Set Over.* PRI-84MW. See footnote, p. 40. 17 min. Loan.

Three methods used to measure the tailstock set-over when turning tapers, and methods of calculating distance tailstock must be set over to cut a given taper.

*Turning Work Held on a Fixture.* PRI-85MW. See footnote, p. 40. 21 min. Loan.

How to mount work on a special fixture for machining an irregularly shaped casting which cannot be held in chuck, how to mount and center the fixture on the lathe, and how to grind tools for the machining of brass.

*Turning Work Held on a Mandrel.* PRI-86MW. See footnote, p. 40. 20 min. Loan.

What a mandrel is, and where used to advantage, how to fit the mandrel into the workpiece, how to mount the mandrel and work between centers, how to protect the mandrel from injury by cutting tools, how to cut a bevel using the compound rest, and how to calculate speed and feed, and set controls.

*Turning Work of Two Diameters.* PRI-87MW. See footnote, p. 40. 14 min. Loan.

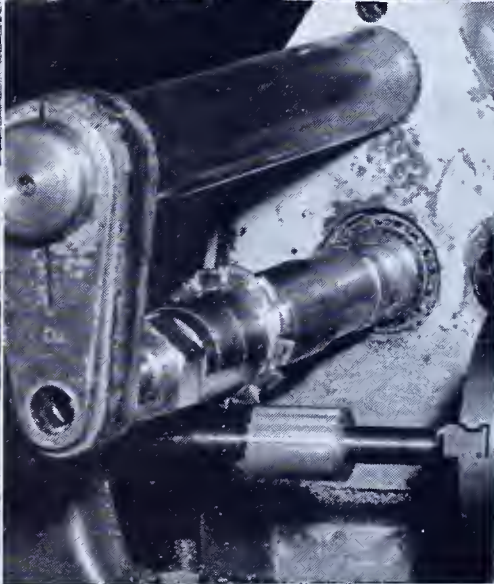
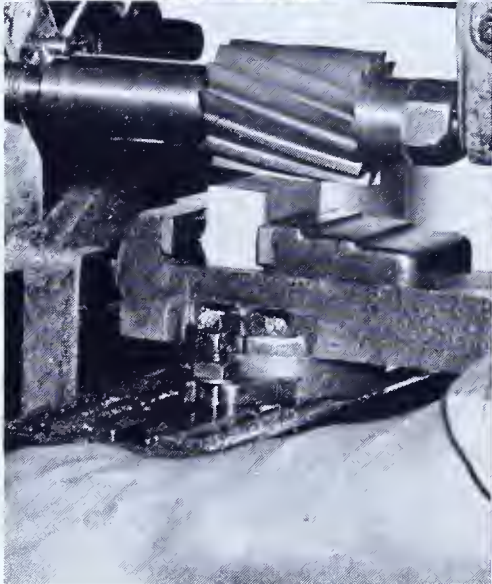
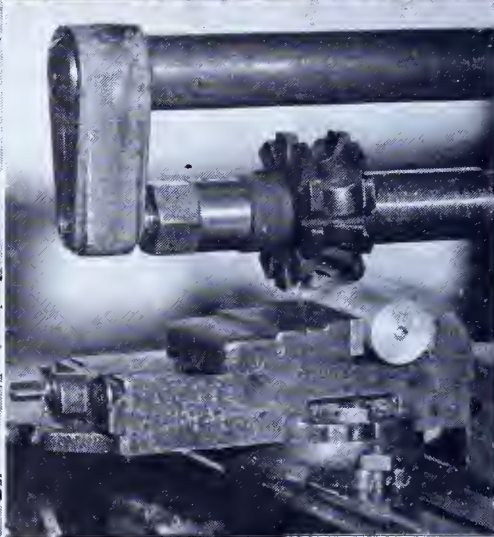
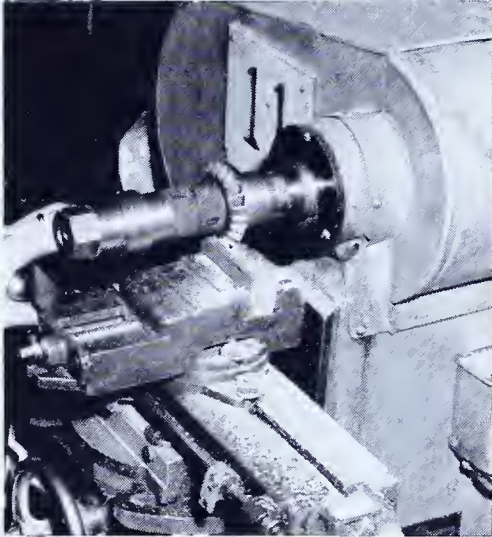
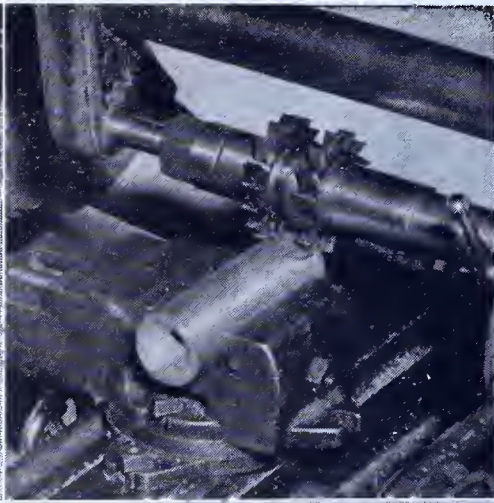
Sequence of operations to turn a gear blank with its shaft from a solid piece of round stock. Each shaft is rough-turned and finished-turned to size before the piece is reversed between centers. The sides of the gear blank are finished after the piece has been turned to size.

## **Milling Machines**

*Basic Machines—The Milling Machine.* PRI-61MW. See footnote, p. 40. 15 min. Loan.

How the milling machine removes metal, how the cutter is held, how power is applied, how spindle speeds are changed, how work is supported and fed to the cutter, and how the rate of feed is changed.





**MILLING MACHINE OPERATIONS**

*Milling Machine.* PRI-61MW. See footnote, p. 40. 8 min. Loan.

The basic operating principle of the milling machine, how to set up cutters on the arbor, and how to control movements of the table by power traverse and by hand. Types of jobs done on milling machines.

*Milling Machine Operations.* Film Production Company, 3650 N. Fremont Avenue, Minneapolis, Minn. 2 reels. Rental-Loan.

The construction of the milling machine is analyzed and types of cutters are shown in action. Kinds of milling, holding methods, and a variety of jobs adaptable to the machine are shown.

*Plain Indexing and Cutting a Spur Gear.* PRI-63MW. See footnote, p. 40. 26 min. Loan.

The principle and operation of the dividing head shown in cutting an eight-pitch spur gear with 36 teeth. Accuracy in setup and mounting is emphasized.

*Straddle Milling.* PRI-83MW. See footnote, p. 40. 17 min. Loan.

How to straddle mill the bosses on connecting rods to proper width when connecting rods are held in a fixture. Animation explains how to select spacing collars, correct locations of four cutters, and to mill bosses on both connection rods at same time.

*Milling Machines.* PRI-FS-2MW. See footnote, p. 40. Slide film, 61 frames. Loan.

Describes the milling machine, basic cutter types, milling speeds, feeds, and types.

*Milling Machine Practice.* Kearney & Trecker Corporation, 6784 W. National Avenue, Milwaukee 14, Wis. Slide films, 50 frames. Loan.

Shows milling practice in all its phases.

## **Planing and Shaping**

*Basic Machines—The Shaper.* PRI-74MW. See footnote, p. 40. 15 min. Loan.

How the shaper removes metal, how motion is imparted to the ram, how cutting tool is mounted and positioned, how the workpiece is mounted, how the cutting speed of the tool and the rate of table feed are adjusted.

*Cutting a Keyway on End of a Finished Shaft.* PRI-10MW. See footnote, p. 40. 13 min. Loan.

The use of a shaper in cutting a keyway in a steel shaft. How to select the cutting tools, how to secure the work in a vise, and how to set the stroke and speed of the shaper.

*Machine Tools: The Shaper.* PRI-74MW. See footnote, p. 40. Slide film. Loan.

Nomenclature, practical uses and operation of the shaper.

*Machining a Cast Iron Rectangular Block.* PRI-54MW. See footnote, p. 40. 25 min. Loan.

The use of parallels to set a block in a shaper vise for machining all six surfaces square with each other, techniques for finishing cuts, setting the machine for stroke, speed, cross-feed and depth of cut.

*Machining a Tool Steel V Block.* PRI-55MW. See footnote, p. 40. 21 min. Loan.

A solid rectangular tool steel block is set up in a shaper vise after being laid out with V and rectangular grooves. The proper setup of the work to assure parallelism of cut, the method for selecting stroke, speed, cross-feed, and depth of cut. Selecting and setting of roughing and finishing tools are emphasized.

*Shapers, The.* PRI-FS-MW. See footnote, p. 40. Slide film, 52 frames. Loan.

Basic parts and functions of the shaper, tools, types of work performed, and safety hints.

## Precision Measurement, Inspection, and Testing

*Bevel Protractor.* PRI-1MW. See footnote, p. 40. 15 min. Loan.

The principle of the bevel protractor, how to set and read, how to use to lay out angular work and check angles on finished work, and its care.

*Dial Indicator.* Film Production Company, 3650 N. Fremont Avenue, Minneapolis, Minn. 20 min. Color. Rental-Loan.

Basic facts on how to use the dial indicator.

*Dial Indicator Gauges.* Film Production Company, 3650 N. Fremont Avenue, Minneapolis, Minn. 18 min. Color. Rental-Loan.

Basic facts on how to use dial indicator gauges.

*Height Gauges and Test Indicators.* PRI-49MW. See footnote, p. 40. 12 min. Loan.

The fundamental principles of the vernier height gauge, with forms of standard indicators. A vernier height gauge is used to lay out holes on an angle plate. Standard indicators check the accuracy of the finished layout, the flatness of a surface, and centering.

*Micrometer.* PRI-58MW. See footnote, p. 40. 15 min. Loan.

Forms of the micrometer—outside, inside and depth micrometers—correct reading of barrel and thimble scales, use and care.

*Steel Rule.* PRI-82MW. See footnote, p. 40. 14 min. Loan.

How to read steel rules, fractional graduations, how to use the flexible hook and rule-type depth gauges and combination squares, how to lay out holes with a combination square, how to use inside and outside calipers to transfer dimensions to and from steel rules.

## METALS

### Copper

*Copper Leaching and Concentration.* U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa. 15 min. Loan.

Operations in preparation of copper ore for the smelter (crushers, ball mills, belt conveyors, classifiers) and the operation of flotation cells in graphic diagram.

*Copper Mining in Arizona.* U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa. 45 min. Loan.

Open pit and underground mining methods, diamond drilling, air drilling and blasting, churn drilling and blasting, tunnel driving, sinking wings and shaft with a rotary drill, and scraping ore into chutes.

*Copper Refining.* U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa. 15 min. Loan.

The conversion of nodes into chemically pure copper by the electrolytic process.

*Copper Smelting.* U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa. 15 min. Loan.

The crushing, roasting, and smelting procedures to convert ore and concentrates into metallic copper, removal of impurities in converters and anode furnaces, and casting anodes.



*From Mine to Consumer.* American Brass Company, Waterbury, Conn. 30 min. Color. Loan.

How copper ore is mined, smelted, and refined, alloying to make brass and the fabrication of copper and alloys into sheets, wire, rods, tubes, and special shapes.

*Manufacture of Anaconda Sheet Copper.* American Brass Company, Waterbury, Conn. 15 min. Loan.

Processes and operations involved in making sheet copper by hot-rolling copper cakes.

*Story of Copper.* U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa. 34 min. Sound.

The complete story of copper: open-pit mining at Morenci, Arizona, and the underground mine at Bisbee, Arizona.

## **Iron and Steel**

*Alloy Steel,* Bethlehem Steel Company, Bethlehem, Pa. 40 min. Loan.

The manufacture of alloy steel, smelting processes and fabrication.

*Alloy Steels—A Story of Their Development.* U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa. 20 min. Loan.

Alloy steels from manufacturer to high-speed tools.

*Drama of Steel.* U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa. 30 min. Loan.

The history of steel-making from the charcoal furnaces of ancient time to the modern blast and open-hearth furnaces.

*Enduro Stainless Steel.* Republic Steel Corp., Republic Bldg., Cleveland, O. 40 min. Loan.

Covers the manufacture of stainless steel from mining in Rhodesia to the mirror-finished sheet.

*How Steel Is Made.* Bethlehem Steel Company, Bethlehem Pa. 40 min. Loan.

Blast furnace, Bessemer furnace and open-hearth operations. Animated drawings of what takes place in the blast furnace and open-hearth. Control of slag in the open-hearth. Spectrographic analysis. Cross-sections of Bessemer, electric, and cupola furnaces. Standard rolling operations. Hammer and press forges.

*Making and Shaping of Steel.* U. S. Steel Corporation of Delaware, 436 7th Avenue, Pittsburgh 30, Pa. 70 min., sound; 90 min., silent.

Reel 1: Raw Materials—underground mining of iron ore, transportation and delivery. Reel 2: Making Steel—open hearth, electric furnaces, etc. Reel 3: Flat-rolled products. Reel 4: Bars and structural shapes. Reel 5: Rails, wheels, axles. Reel 6: Wire and wire products. Reel 7: Pipe and tube manufacture.

*Making of Alloy Steel.* The Bethlehem Steel Company, Bethlehem, Pa. 45 min. Loan.

Preparation and charging of open-hearth furnace, billet preparation, rolling on hand mills, cold drawing, heat treating; finishing operations—straightening, grinding, rough machining and pickling.

*Manufacture of Tool Steel.* Columbia Tool Steel Company, Chicago Heights, Ill. 30 min. Silent. Color. Loan.

Shows the addition of alloys and heat treatment in processing steel into tool steels.

*Melting of Huron Die Steel.* Allegheny Ludlum Corporation, Brackenridge, Pa. 20 min. Color. Loan.

The step-by-step process involved in melting a heat of high carbon and high chromium tool steel. Scenes of electric furnaces in operation, molten metal stages, and the like.

*Stainless Steel.* Allegheny Ludlum Steel Corporation, Brackenridge, Pa. 29 min. Loan.

Steps in the production of stainless steel.

*Steel.* American Institute of Steel Construction, Dept. of Educational Service, 101 Park Avenue, New York 17, N. Y. 25 min. Loan.

Complete story of steel.

*Steel.* American Institute of Steel Construction, Dept. of Educational Service, 101 Park Avenue, New York 17, N. Y. 20 min. Loan.

Steelmaking with off-screen description of production processes.

*Steel.* Vulcan-Crucible Steel Company, West Aliquippa, Pa. 25 min. Loan.

Step-by-step routine in the manufacture of fine steel tools.

*Steel for the Ages.* Allegheny Ludlum Steel Corporation, Brackenridge, Pa. 30 min. Color. Loan.

Studies of the production of high-alloy steels.

*Steel—Man's Servant.* U. S. Steel Corporation of Delaware, 436 7th Avenue, Pittsburgh 30, Pa. 38 min. Loan.

Description of the steel industry from mining to finished product.

*Story of Carbon Steel.* U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa. 30 min. Loan.

Manufacture of carbon steel.

*There's a Job to be Done.* Allegheny Ludlum Steel Corporation, Brackenridge, Pa. 30 min. Loan.

The manufacture of alloy steels.

*This Is Steel.* Bethlehem Steel Company, Bethlehem, Pa. 28 min. Loan.

Production of pig iron in blast furnaces, refining of iron into steel, and the shaping of steel.

## SAFETY FILMS

*Eyes Have It, The.* National Society for the Prevention of Blindness, 1790 Broadway, New York 19, N. Y., and Pullman Company, Department of Safety and Compensation, 222 W. North Bank Drive, Chicago, Ill. 20 min. 35 mm., sound slide. Loan.

*Fall of Man.* Zurich Insurance Companies, 135 South LaSalle Street, Chicago 3, Ill. 5 min. 35 mm., sound slide. Loan.

Major causes of falls, on and off the job, and how to prevent them.

*Fire Thief.* National Safety Council, 20 North Wacker Drive, Chicago, Ill. 20 min. 35 mm., sound slide. Rent or purchase.

Industry's great enemy—fire—and how employees can prevent it; teacher's manual included.



*Grinding-Wheel Safety.* Norton Company, Worcester 6, Mass. 20 min. Color. Loan.

Principal causes of grinding-wheel breakage, emphasizing need for proper guarding and selection of wheels. Based on American Standard Safety Code for abrasive wheels.

*Magic Carpet, The.* Waverly Petroleum Products Company, Drexel Building, Philadelphia 6, Pa. 11 min. Loan.

How to prevent slipping accidents and fire hazards.

*Man-Handled.* Zurich Insurance Companies, 135 South LaSalle Street, Chicago 3, Ill. 15 min. 35 mm., sound slide. Loan.

Accidents caused by unsafe handling.

*Men Who Come Back.* Industrial Commission of Ohio, Room 611, State Building, Columbus 15, O. 24 min. Color. Loan.

Hazards common to most industries, machine guarding, point of operation guarding, good housekeeping, material handling, etc.

*My Eye Deal.* National Safety Council, 20 N. Wacker Drive, Chicago, Ill. 10 min. 35 mm., sound slide. Loan.

Color cartoon teaching necessity for wearing goggles.

*Prevention Is Better.* Railway Express Agency, Inc., 230 Park Avenue, New York 17, N. Y. 10 min. 25 mm., sound slide. Purchase.

Methods to prevent personal injuries, primarily industrial, but application is broad enough to fit many situations.

*Safe Practices In Metalworking Engine Lathe.* Jam Handy Organization, 2821 East Grand Blvd., Detroit 11, Mich. 35 mm., sound slide. Purchase.

Kit contains 11 slidefilms on the safe operation of the engine lathe, covering dressing safely, avoiding injury, operation and control of the machine, turning tools, chucking work, setting tools, mounting work and operations. Each film is divided into teaching units or lessons and reviews. Discussion questions are incorporated with each lesson to assist the instructor in guiding group participation. Lessons vary from 5 to 18 minutes.

*Series 300: Safeguarding the Eyes.* Industrial Safety Education Service, 542 South Dearborn Street, Chicago 5, Ill. 18 min. 16 mm., silent. Color. Purchase or rent.

Safeguarding eyes and machines, including many different types of grinding operations showing the advantages of using illuminated shatterproof eye shields and illuminated magnifiers.

*Think Safety—Live Safely.* Zurich Insurance Companies, 135 South LaSalle Street, Chicago 3, Ill. 15 min. 35 mm., sound slide. Loan.

Chief personal behavior causes of accidents.

*Three Blind Mice.* Twyman Films, Inc., 29 Central Avenue, Dayton 1, O., or Indiana University, Audio-Visual Center, Bloomington, Ind. 5 min. Loan.

This animated safety film demonstrates the importance of observing safety precautions in the factory.

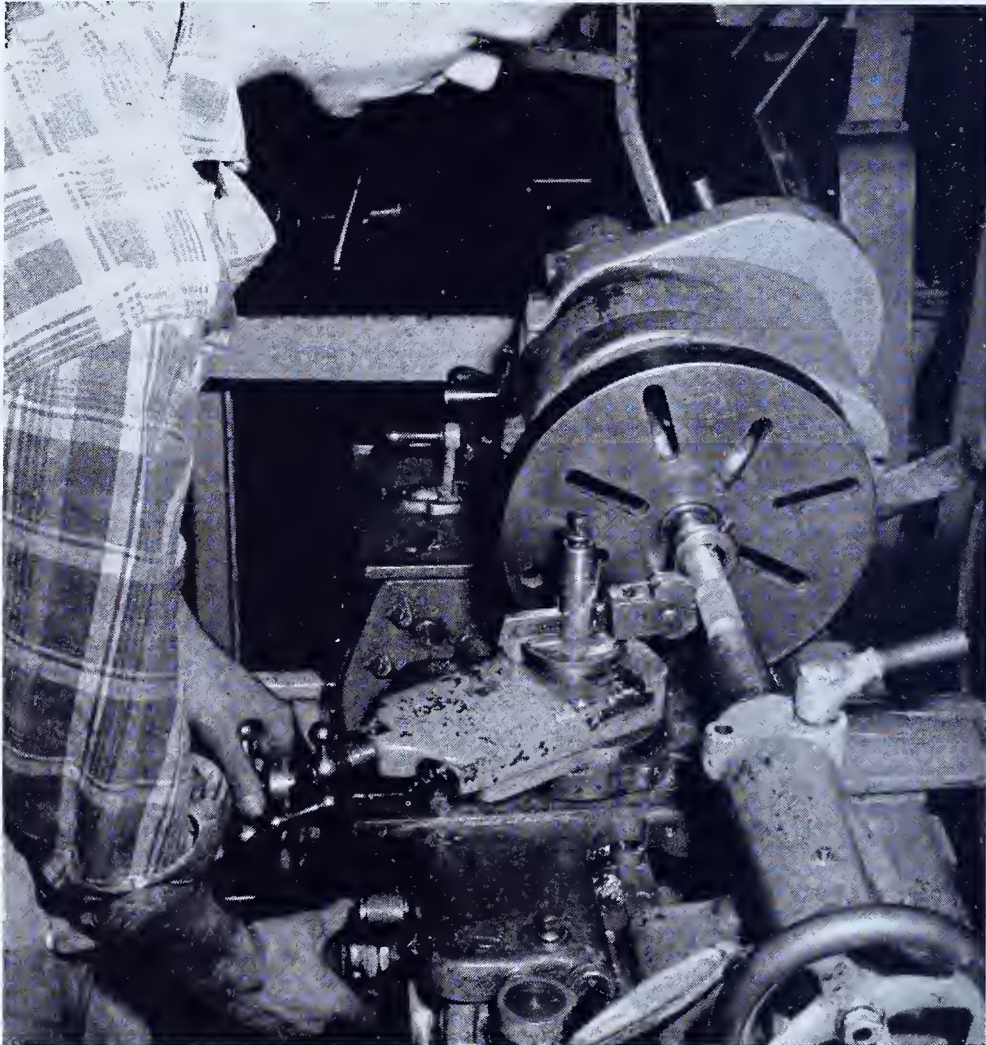
*To Live In Darkness.* The Princeton Film Center, 55 Mountain Avenue, Princeton, N.J.; Twyman Films, Inc., 29 Central Avenue, Dayton 1, O.; Idaho State College, Educational Film Library, Pocatello, Idaho; Indiana University, Audio-Visual Center, Bloomington, Ind.; New York University Film Library, 26 Washington Place, New York 3, N. Y.; and Castle Films Division, United World Films, Inc., 445 Park Avenue, New York 22, N. Y.

*Tomorrow's Too Late.* Visual Art Films, 118 Ninth Street, Pittsburgh, Pennsylvania or Vision Educational Production, 509 Fifth Avenue, New York 17, N. Y. 10 min. Rent or purchase.

Safety rules, misuse of tools, care of colds, proper food for health, safety rules, dermatitis, mental adjustment to changes.

*Your Future Is In Sight.* Zurich Insurance Companies, 135 S. LaSalle St., Chicago 3, Ill. 15 min. 35 mm., sound slide. Loan.

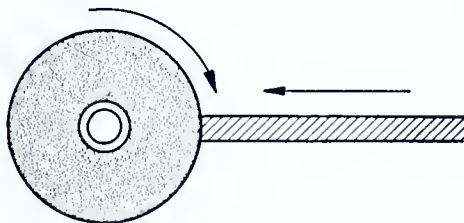
How eyes work, and why goggles should be worn wherever there is the possibility of an eye hazard. How it feels to be blind.



**KNURLING**

# 6 *Equipment and Supplies*

## EQUIPMENT AND SUPPLY LISTS



THE INDUSTRIAL ARTS TEACHER is frequently called on to specify equipment for a new shop, or to recommend replacements for worn-out tools, machinery, and supplies. No two schools have the same budget, physical plant, or education program; therefore, all machinery and supply needs must be selected to fit the local needs and resources. Some of the questions to be answered and specific factors to be considered in determining the quantity and the type of equipment selected for the Industrial Arts shop are as follows:

1. Do the tools, machinery and other equipment have definite application in carrying out the objectives, scope, and content of the course of study?
2. Will the shop serve junior high school pupils, senior high school pupils, or both groups?
3. What types of activities will be taught?
4. The size of the class
5. The amount of funds available
6. The suitability of the equipment available
7. Is the equipment of modern design, and can it be easily maintained?
8. Does the equipment have adequate safety devices?
9. Is the equipment mechanically designed for safe operation under ordinary operating conditions?
10. Has the flexibility of the equipment been considered?

### **How to Specify and Order Equipment**

When making purchases of equipment, it is essential that complete written specifications be prepared to submit to distributors for bidding purposes. Shop teachers can request catalogs from the manufacturers of hand tools, machinery, and supplies. These catalogs contain com-





plete descriptions of the item and a catalog number identification. Most distributors use the same descriptions and numbers as those in manufacturer's catalog.

The specification sheet or order sheet must list all necessary information on each item, in a uniform manner, and should contain the following information:

1. Item number
2. Quantity desired
3. Unit of measure
4. Catalog number
5. Name of item
6. Complete description of item—size, color, electrical specification, and accessories.

Specifications should ordinarily be written around the specific piece of equipment which comes closest to the teacher's requirements. Write "or equal" following the item, or include these words in "Instructions to Bidders".

### **How to Keep a Shop Inventory**

The Industrial Arts teacher is responsible to the administrative official of the school for a periodic accurate accounting of all shop tools and materials. Among the many advantages of keeping an accurate inventory are the following:

1. It provides a periodic check on the condition and quantity of equipment and supplies.
2. The teacher knows at all times how much stock is on hand.
3. It provides accurate information concerning the amount of material used during the term.
4. It provides a basis for determining what is needed for the new term.
5. It provides justification of quantities requested on requisitions to the Superintendent of Schools and the Board of School Directors.

A suggested inventory form is shown on page 55. Each item listed should have as complete a description as possible. Near the close of the school term the administrative official of the school will list, in the *Received* column, the quantities of items purchased during the current year. This information can be secured easily from the purchase orders. At the close of the school year the teacher checks and lists quantities in the column *On Hand at End of Term* or in one of the *Expended* columns. Then the quantities are checked against quantities listed on the inventory of the previous year, and any discrepancies checked. When the new school term opens, the same inventory is checked and quantities recorded in the column *On Hand at Beginning of Term*.



## Equipment List

The tools, machinery, and other equipment suggested in this bulletin are based on the minimum requirements of metal machining for five pupils in a comprehensive general shop. A larger number of pupils can be accommodated by increasing the amounts proportionately. The approximate prices of tools, machinery, and other equipment are as of July 1, 1953.

HAND TOOLS			
Quantity	Item		Approximate Cost
	Calipers		
1 pr.	hermaphrodite, lock joint, 6" .....		\$1.75
1	inside micrometer, with case, 4 rods, 2"-8" .....		10.00
3 pr.	inside spring, 6" .....		4.50
2	outside micrometer, 0"-1" .....		20.00
1	outside micrometer, 1"-2" .....		11.00
3 pr.	outside spring, 6" .....		4.50
3	Cards, file .....		2.25
6	Clamps, "C", malleable iron, 3" .....		6.00
	Countersinks, straight-shank, 82°, high speed		
1	1/2" .....		2.25
1	5/8" .....		2.50
1	3/4" .....		3.15
	Dividers		
1 pr.	spring, 3" .....		.90
1 pr.	spring, 6" .....		1.50
1 pr.	spring, 8" .....		1.85
1	Dresser, hooded emery wheel, #1 .....		2.10
	Drills		
1 set	center, one each: A1, C2, Dk, Ek, E2, F1, F2, high speed .....		8.50
1 set	jobbers, straight-shank, high speed, with stand, 1/16"-1/2" by 64th .....		27.50
1 set	straight-shank wire, high speed, with stand, No. 1-No. 60 .....		22.50
5	Dusters, bench, 8" .....		3.75
1 set	Figures, steel hand-cut, character size 1/4", 9 numerals..		5.75
	Files		
2	flat mill, bastard-cut, 10" .....		2.00
4	flat mill, second-cut, 10" .....		4.00
2	half-round, second-cut, 10" .....		2.00
2	round, second-cut, 10" .....		1.90
	Gauges		
1	center .....		2.00
1	jobbers drill .....		3.25
1	micrometer depth, 0"-3" .....		10.00
1	screwpitch, pitches 6-60 .....		2.00
1	surface, 3" base, 9" spindle .....		5.00
1	tap and drill .....		2.75
6 pr.	Goggles, industrial safety .....		9.00

<i>Quantity</i>	<i>Item</i>	<i>Approximate Cost</i>
<b>Hammers</b>		
2	ball peen, 16 oz. ....	3.00
2	ball peen, 8 oz. ....	2.50
1	ball peen, 1 oz. ....	1.00
2	lead, 32 oz. ....	3.00
1	Indicator, universal junior ....	7.50
1 set	Letters, steel hand-cut, character size 1/4", 27 letters ...	16.50
<b>Levels, bench metal, double plumbs</b>		
1	18" ....	6.50
1	4" ....	2.65
<b>Oilers, welded steel</b>		
2	bent nozzle, 9", 1/3 pt. ....	1.50
2	bent nozzle, 6", 1/3 pt. ....	1.30
2	straight nozzle, 4", 1/3 pt. ....	1.00
2 prs.	Pliers, combination, 6" ....	2.50
<b>Punches, center</b>		
2	3/8" ....	.50
2	1/2" ....	.90
<b>Rules, steel, No. 4 graduation</b>		
5	6" ....	6.00
2	12" ....	4.00
2	Saws, hack, solid frame, 12" blade ...	4.00
<b>Screwdrivers, perfect handle</b>		
1	4" ....	.95
1	5" ....	1.15
2	6" ....	2.60
2	8" ....	3.00
1	10" ....	1.85
3	Scribers, improved ....	2.55
<b>Sets</b>		
1	combination, 12" ....	13.50
1	screwplate, complete with wooden case, straight-handle tap wrench, stock, one hand tap and one round adjustable die of the following sizes: 4-36, 6-32, 8-32, 10-24, 12-24, and 14-20 ....	10.00
1	screwplate, complete with wooden case, one straight-handle tap wrench, one stock, one hand tap, one die and collet of the following sizes: 1/4"-20, 5/16"-18, 3/8"-16, 7/16"-14, 1/2"-13, 5/8"-11, 3/4"-10, 7/8"-9, 1"-8 ....	62.50
4	Squares, double, 4" ....	8.40
1	Stone, oil, combination coarse and fine, in hardwood case, 1" x 2" x 8" ....	2.00
2	Vises, machinist stationary, 3" jaws ....	40.00
<b>Wrenches</b>		
1 set	safety setscrew, set of 11 wrenches, for hollow set-screws from No. 4-3/4" and socket cap screws from No. 4-1/2" ....	1.75
	open end, 15° angle, double-head, dropped forged	
1	3/8" and 7/16" ....	.50
1	1/2" and 19/32" ....	.60

<i>Quantity</i>	<i>Item</i>	<i>Approximate Cost</i>
	open end, 15° angle, double-head, dropped forged (continued)	
1	9/16" and 5/8" .....	.70
1	11/16" and 25/32" .....	.85
1	3/4" and 7/8" .....	1.05
1	15/16" and 1" .....	1.25
1	13/16" and 11/4" .....	2.20
1	1 1/8" and 1 5/16" .....	2.20
1	T-handle tap, 5/32"-1/4" square capacity .....	1.75
1	T-handle tap, 3/16"-5/16" square capacity .....	2.65
	Total	<u>\$414.50</u>

### MACHINERY

1	Lathe, engine, precision, quick change gear type, under- neath motor drive, back geared, belt drive to spindle, metal column base with three drawers, 9" swing, 3 1/2' bed, 22" between centers, thread cutting stop, thread dial indicator, motor belt, 1/2 H.P., 1800 R.P.M., 115/230 volt reversible motor, drum type across the line switch and regular standard equipment .....	642.00
	<i>Accessories for the above:</i>	
1	Bar, brass-head center ejector .....	2.50
	Chucks	
1	4-jaw independent, 6", fitted to above lathe ....	39.00
1	3-jaw, universal, 5", fitted to above lathe .....	44.00
	Dogs, bent tail safety	
1	3/8" .....	1.00
1	1/2" .....	1.10
1	3/4" .....	1.20
1	1" .....	1.40
	Tools	
1	knurling, medium diamond-pattern knurl, 5/16" x 3/4" x 5" holder .....	9.00
1	right-hand off-set cutting-off, 3/8" x 7/8" shank, 3/32" x 5/8" cutter .....	4.80
	Toolholders	
1	boring, 3/8" x 3/4" shank .....	6.65
1	left-hand off-set turning, 1/4" x 1/4" cutter capacity .....	4.55
1	right-hand off-set turning, 1/4" x 1/4" cutter capacity .....	4.55
1	straight turning, 1/4" x 1/4" cutter capacity ....	4.55
	Total	<u>\$766.30</u>
1	Lathe, engine, precision, quick change gear type, under- neath motor drive, back geared, belt drive to spindle, 13" swing, 6' bed; 40" between centers, taper attach- ment, thread dial indicator, thread cutting stop, motor belt, 1 H.P., 1800 R.P.M., 115/230 volt reversible motor, drum type across the line control switch and regular standard equipment .....	\$1,663.00

Quantity	Item	Approximate Cost
<i>Accessories for the above:</i>		
1	Bar, brass-head center ejector . . . . .	3.25
Chucks		
1	4-jaw independent, 7½", fitted to above lathe . .	88.00
	3-jaw universal, 6", fitted to above lathe . . . . .	101.00
Dogs, bent tail safety		
1	½" . . . . .	1.10
1	¾" . . . . .	1.20
1	1" . . . . .	1.40
1	1½" . . . . .	2.00
Tools		
1	boring with 90°, 45°, 30° cutter caps ½" x 1½" shank, ¾" bar . . . . .	9.30
1	revolving head knurling, fine, medium and coarse diamond pattern knurls, ⅜" x 7⁄8" x 5½" holder . . . . .	12.80
1	right-hand off-set cutting-off, ½" x 1½" shank, ⅛" x ¾" cutter . . . . .	5.75
Toolholders		
1	left-hand off-set turning, ⅝" x ⅝" cutter capacity . . . . .	5.20
1	right-hand off-set turning, ⅝" x ⅝" cutter capacity . . . . .	5.20
1	straight turning, ⅝" x ⅝" cutter capacity . . . . .	5.20
Total		<u>\$1,904.40</u>
1	Hack saw, motor-driven metal-cutting, 6" x 6" capacity, 12" blade, 6" stroke, automatic stop, plain screw type vise, ½ H.P., 1800 R.P.M., 115/230 volt motor, starting switch, belt and gear guards . . . . .	\$329.00
1	Drill press, floor model, 14", V-belt drive belt, belt guard, No. 2 Morse taper spindle, ½ H.P., 1725 R.P.M., 115/230 volt motor and toggle switch . . . . .	180.00
<i>Accessories for the above:</i>		
1	Chuck, drill, 0"-½" capacity, No. 2 Morse taper arbor	9.00
1	Vise, swivelbase drill press, 2½" x 4" capacity . . . .	25.00
Total		<u>\$214.00</u>
1	Machine, milling, horizontal, 16" table, ¾ H.P. Lima drive gearhead 200/440 volt reversible motor, reversing drum type switch 1" arbor, draw bar, 28" cast-iron cabinet column, belts, guards and swivel vise . . . . .	\$751.00
<i>Accessories for the above:</i>		
1	Center, tilting-head index, tailstock and 60 division index plate . . . . .	115.00
Cutters		
	double-angle milling, high speed, 2¾" dia., ½" face, 1" bore	
1	60° included angle . . . . .	7.20
1	90° included angle . . . . .	7.20

<i>Quantity</i>	<i>Item</i>	<i>Approximate Cost</i>
	Mills, two-lipped, spiral end, No. 7, Brown & Sharpe taper shank, high speed	
1	1/4" dia. ....	6.30
1	3/8" dia. ....	6.40
1	1/2" dia. ....	6.50
	Plain milling, high speed, 2 1/2" dia., 1" bore	
1	1/2" face ....	5.10
1	3/4" face ....	6.00
1	1" face ....	6.90
1	2" face ....	16.30
	Saws, metal-slitting with chip clearance, high speed, 4" dia., 1" bore	
1	1/16" face ....	7.90
1	1/8" face ....	8.10
2	Side milling, high speed, 3" dia., 1/2" face, 1" bore ....	16.00
1	Sleeve, milling machine, No. 9 Brown & Sharpe outside taper, No. 7 Brown & Sharpe inside taper ....	6.50
1	Vise, graduated swivel, 3 1/2" x 1 1/8" jaws, and tongue strips ....	38.00
	Total	\$1,010.40
1	Grinder, pedestal tool, with pedestal, "Flud-Lite" eye shields, one fine 7" diameter, 1" face abrasive wheel, one coarse 7" diameter, 1" face abrasive wheel, electric control switch and water pot ....	\$148.00
1	Shaper, metal-working bench, 7" stroke, steel stand, motor belt, swivel vise, belt guards, 1/2 H.P., 1800 R.P.M., 115/230 volt reversible motor and electrical control switch ....	\$668.00
	<i>Accessories for the above:</i>	
1	Shaper extension tool, 1/2" x 7 1/2" bar, 3/16" x 3/16" cutter capacity ....	6.40
1	Shaper tool holder, 1/4" x 1/4" cutter capacity ....	6.40
	Total	\$680.80
1	Grinder, universal tool and cutter floor model* Longitudinal travel of table, 15" Vertical movement of grinding wheel spindle, 7" Cross movement of saddle, 6" Swing of work between centers, 8" dia.	

\* In schools where the expenditure of funds for the universal tool and cutter grinder can not be justified, it is suggested that a tool post grinder be purchased. The tool post grinder can be used in a metal lathe and will do practically all of the operations listed in the "Things to Do" section under grinding, with the exception of surface grinding. Many of these operations can be done on the metal shaper. It may be necessary to make a special holder or mounting device to enable the tool post grinder to be mounted in the particular lathe or shaper. Where the tool post grinder is substituted for the universal tool and cutter grinder, it is suggested that an additional metal lathe be purchased so that it may be set up as a grinding work station.



<i>Quantity</i>	<i>Item</i>	<i>Approximate Cost</i>
	Grinder, Universal tool and cutter floor model (con- tinued)	
	Grinding length of cylindrical work between centers, 10"	
	Table surface, 4" x 24"	
	Height from table to floor, 41"	
	To take grinding wheels 1/2" face, 6" dia.	
	Main spindle motor 1 1/2 H.P., 1750 R.P.M. with fol- lowing attachments: . . . . .	\$1,040.00
1	Center height gauge . . . . .	6.50
1	Coolant pump, reservoir, hose . . . . .	75.00
1	Nozzle and clamp . . . . .	4.75
1	Cup grinding wheel guard . . . . .	2.10
1	Diamond holding bracket . . . . .	3.50
1	Diamond nib . . . . .	16.50
	Grinding wheels with hole to fit spindle of machine:	
1	6" dia. x 1/2" face straight wheel . . . . .	2.10
1	6" dia. x 3/4" face dish wheel . . . . .	2.50
1	6" dia. x 3/32" cut-off wheel . . . . .	1.75
1	5" dia. x 1 1/2" face cup wheel . . . . .	3.50
1	3 1/2" dia. x 1 1/4" flaring cup wheel . . . . .	2.50
1	Internal grinding attachment . . . . .	170.00
1	Straight grinding wheel guard . . . . .	2.75
1	Spindle extensions (2) to fit main spindle . . . .	55.00
1	Tilting swivel vise . . . . .	42.00
1	Universal chuck with inside and outside jaws . .	120.00
1	Universal tooth rest with four-tooth blades . . .	11.00
1	Universal face mill grinding attachment equipped with 1/30 H.P., 1425 R.P.M. motor, belt guard, pulley drive pins, adjustable motor base, (5) dogs to take arbors from 1/4"-1 1/4", live center, and collets to reduce, No. 12 B & S taper to No. 10 B & S taper, No. 12 B & S taper to No. 9 B & S taper, No. 12 B & S taper to No. 7 B & S taper . . . .	195.00
1	Standard set of wrenches to fit all spindle nuts, dogs, and machine adjustments . . . . .	5.30
	Total	<u>\$1,761.75</u>
1	Bench, work, approximately 1 1/2" thick, 30" high, 30" wide, 96" long, maple or birch top (to be constructed by pupils) materials, legs, lumber, hardware . . . . .	\$30.00
1	Can, metal automatic oily waste 6-gallon capacity . . . .	12.00
	Total	<u>\$42.00</u>
	Grand total of machinery and equip- ment, approximately . . . . .	<u>\$7,271.15</u>

## Consumable Supply List

The supplies suggested in this bulletin are based on the minimum requirements of the metal machining area for five pupils in a comprehensive general shop operating six periods per day for a school year of 180 days. This list of supplies is only suggestive and may be changed by the teacher to meet the requirements of his specific plan of instruction. It should only be used as a guide and not as a final form for requisitioning. Prices given are as of July 1, 1953.

<i>Quantity</i>	<i>Item</i>	<i>Approximate Cost</i>
	Blades hand hack-saw, flexible back, 12" long	
6 doz.	18 teeth per inch .....	\$35.50
6 doz.	24 teeth per inch .....	35.50
	Blades, power hack-saw, all hard, 12" long	
3 doz.	6 teeth per inch .....	17.25
3 doz.	10 teeth per inch .....	17.25
	Bits, lathe tool, high speed	
25	$\frac{1}{4}" \times \frac{1}{4}" \times 2\frac{1}{8}"$ .....	5.00
15	$\frac{5}{16}" \times \frac{5}{16}" \times 2\frac{3}{4}"$ .....	5.40
1 pt.	Blue, layout .....	.75
	Brass, cold-drawn, 12' bars	
1 bar	$\frac{3}{4}"$ dia. ....	10.75
1 bar	1" dia. ....	17.90
1 bar	$1\frac{1}{2}"$ dia. ....	37.35
1 qt.	Cement, waterproof leather belt .....	.75
	Cloth, abrasive, aloxite, 1" wide, 50 yds. per roll	
1 roll	60 grit .....	6.50
1 roll	80 grit .....	6.00
1 roll	100 grit .....	5.80
1 roll	150 grit .....	5.80
6	Cutters, emery wheel dresser, No. 1 .....	1.25
1 qt.	Dressing, neatsfoot belt .....	1.25
	Handles, screw-on file	
6	No. 2 .....	.90
6	No. 3 .....	1.00
6	No. 4 .....	1.25
1 doz.	Lacers, rawhide, $\frac{1}{4}"$ wide, 36" long .....	2.50
2 lbs.	Lead, white .....	.90
	Nuts, hexagon	
1 gross	6-32 .....	.70
1 gross	8-32 .....	.75
1 gross	10-24 .....	.85
1 gross	$\frac{1}{4}"$ -20 .....	1.00
25	$\frac{5}{16}"$ -18 .....	1.45
25	$\frac{3}{8}"$ -16 .....	1.80
	Oil	
3 oz.	instrument .....	.35
2 gals.	machine, S. A. E. No. 20 .....	2.50
2 gals.	soluble .....	2.50

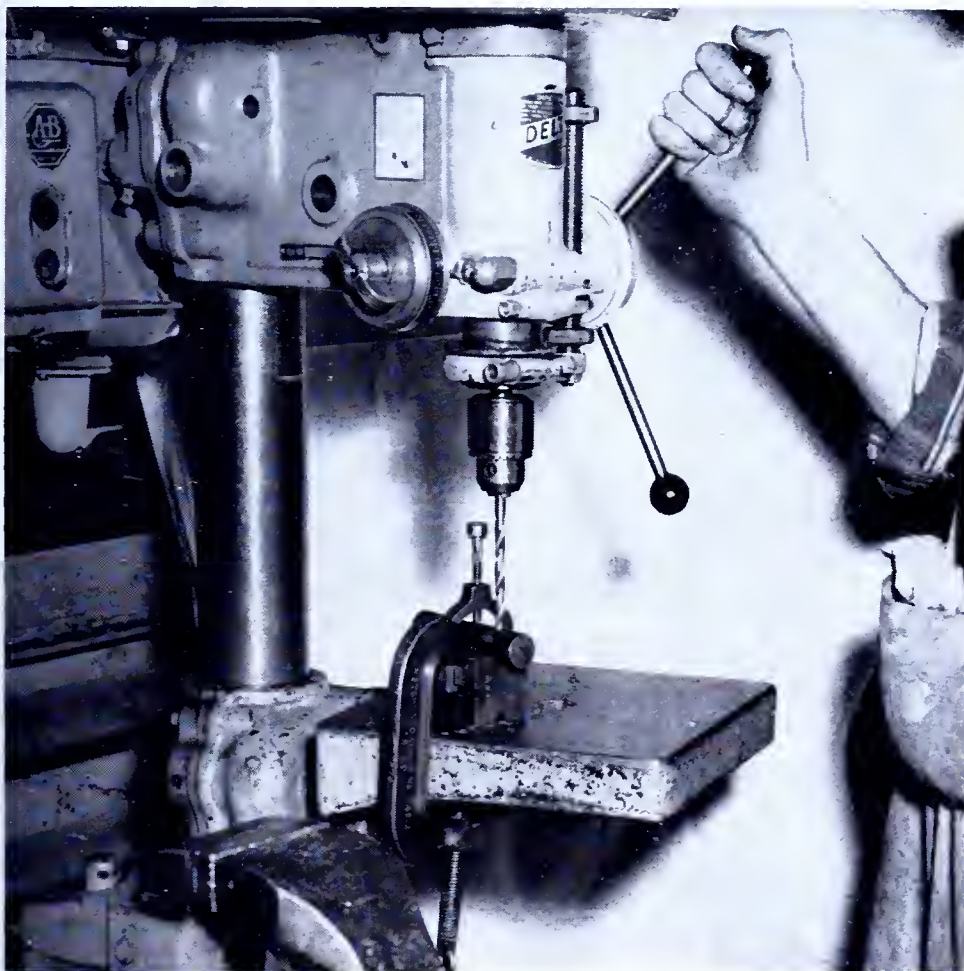
<i>Quantity</i>	<i>Item</i>	<i>Approximate Cost</i>
	Oil (continued)	
2 gals.	spindle .....	4.00
1 gal.	threading .....	4.25
	Pipe, black iron, 20' length	
1 length	3/4" .....	2.00
	Rod, drill, round, 3' bars	
6	1/16" dia. ....	.65
10	1/8" dia. ....	1.65
5	3/16" dia. ....	1.20
10	1/4" dia. ....	3.20
5	5/16" dia. ....	2.35
12	3/8" dia. ....	8.15
15	1/2" dia. ....	16.40
8	3/4" dia. ....	19.85
5	1" dia. ....	22.00
	Rod, drill, square, 3' bars	
3	1/8" x 1/8" .....	.65
3	1/4" x 1/4" .....	1.25
3	3/8" x 3/8" .....	2.65
3	1/2" x 1/2" .....	4.20
3	1" x 1" .....	16.85
	Screws	
	cap, hexagon head	
	1/4"-20	
25	1/2" long .....	.34
25	3/4" long .....	.36
25	1" long .....	.45
	5/16"-18	
25	1" long .....	.48
25	1 1/2" long .....	.58
	3/8"-16	
25	3/4" long .....	.50
25	1" long .....	.58
25	1 1/2" long .....	.69
	machine, flat head	
	6-32	
1 gross	1/2" long .....	.54
1 gross	3/4" long .....	.60
1 gross	1" long .....	.70
	8-32	
1 gross	1/2" long .....	.70
1 gross	3/4" long .....	.77
1 gross	1" long .....	.88
	10-24	
1 gross	1/2" long .....	.77
1 gross	3/4" long .....	.87
1 gross	1" long .....	.98
	machine, round head	
	6-32	
1 gross	1/2" long .....	.54
1 gross	3/4" long .....	.60
1 gross	1" long .....	.70

<i>Quantity</i>	<i>Item</i>	<i>Approximate Cost</i>
	machine, round head (continued)	
	8-32	
1 gross	1/2" long .....	.70
1 gross	3/4" long .....	.77
1 gross	1" long .....	.88
	10-24	
1 gross	1/2" long .....	.77
1 gross	3/4" long .....	.87
1 gross	1" long .....	.98
	Steel, cold-rolled, 12' bars	
	flat	
1 bar	1/8" x 2" .....	1.75
1 bar	1/4" x 1" .....	1.75
2 bars	1/4" x 2" .....	6.10
1 bar	1/4" x 3" .....	4.60
2 bars	1/2" x 2" .....	11.85
1 bar	1/2" x 3" .....	8.90
	hexagon	
1 bar	3/4" .....	2.75
1 bar	7/8" .....	3.75
1 bar	1" .....	4.85
	round	
5 bars	1/8" dia. ....	.45
5 bars	3/16" dia. ....	.50
8 bars	1/4" dia. ....	2.50
3 bars	5/16" dia. ....	1.40
5 bars	3/8" dia. ....	3.25
8 bars	1/2" dia. ....	9.15
6 bars	3/4" dia. ....	14.70
5 bars	1" dia. ....	21.65
1 bar	1 1/4" dia. ....	6.75
1 bar	1 1/2" dia. ....	9.65
1 bar	2" dia. ....	17.30
	square	
2 bars	1/4" x 1/4" .....	.80
4 bars	3/8" x 3/8" .....	3.35
6 bars	1/2" x 1/2" .....	8.75
6 bars	3/4" x 3/4" .....	18.75
3 bars	1" x 1" .....	16.65
1 bar	1 1/2" x 1 1/2" .....	12.30
1 bar	2" x 2" .....	22.00
	Steel, carbon tool, .65-.75 per cent carbon, 10' bars	
	round	
bar	1 1/4" dia. ....	23.15
	square	
1 bar	1" x 1" .....	19.40
1 bar	2 3/4" x 2 3/4" .....	132.40
25 lbs.	Waste, cotton, white .....	10.00
	Wire, steel spring, round	
1/2 lb.	.015" dia. ....	1.50
1/2 lb.	.025" dia. ....	1.50
	Total	\$761.50

## Storage of Tools, Supplies, and Projects

The storage and arrangement of tools depend largely on the physical layout of the shop, types of activities, size of class, money available, and the ease with which the tools can be checked at the end of the shop period.

Present trends are away from the traditional toolroom in favor of the open tool panel. The tool panel is fastened to the wall and contains tools normally used in the particular work area. The panel has a light background, on which is painted a silhouette of each tool. This method of storage saves pupil time in obtaining and returning tools and facilitates the teacher's task in checking them. Additional information on tool control can be found in *Industrial Arts in Pennsylvania*, Bulletin 331, Department of Public Instruction, pages 91-93.

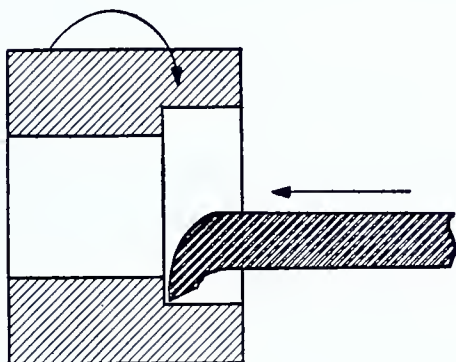


DRILLING IN A V-BLOCK





## 7 Suggested Shop Layout



THE SHOP LAYOUT suggested on page 66 lends itself very well to a junior-senior school program. The two-shop arrangement features a common washroom and planning area. It is so arranged that one shop can be closed during evening school classes. The shop shown is equipped for the following activities:

- |                    |                  |
|--------------------|------------------|
| 1. Metal Machining | 4. Woodworking   |
| 2. Sheet Metal     | 5. Metal Forming |
| 3. Plastics        | 6. Planning      |

The ceramics and graphic arts areas, partially shown, are activities of an adjoining comprehensive general Industrial Arts shop.

These activities lend themselves well to actual industrial situations. Projects are designed in the Planning area, patterns made in Woodworking, a cast is made in Metal Forming, it is machined in the Metal Machining area, and embellished in the Plastics area.

Equipment in the Metal Machining area includes a milling machine, universal grinder, shaper, drill press, pedestal grinder, and three metal lathes. The power hack saw is located near the door to the storage area, where stock can be cut to size to save handling.

The plan for these twin shops can be in a separate building adjacent to the main building, or it can be an integral part of it.

The teacher in this dual shop would have theoretical control of approximately 1,920 square feet of floor space, as shown by the broken line on the plan. The total area of the shop shown is 1,280 square feet, excluding planning, storage, and washroom facilities.

